THE JOURNAL OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 36 JANUARY 1914 Number 1

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COMING MEETINGS OF THE SOCIETY

January 9, New York City, Engineering Societies Building. Joint meeting with the American Institute of Electrical Engineers and the New York Section of the American Electrochemical Society. Subject: The Power Problem in the Electrolytic Deposition of Metals: Papers, The Limitation of the Problem, Lawrence Addicks, A.E.S.; The Mechanical Side of the Problem, H. E. Longwell, Am.Soc.M.E.; The Electrical Side of the Problem, F. D. Newbury, Am.Inst.E.E. The American Institute of Electrical Engineers will give a smoker in their rooms at the close of the meeting, to which the membership is invited.

January 17, Philadelphia, Pa. Joint meeting with the Engineers Club of Philadelphia. Subject: Some Recent Improvements in Steam Locomotives, George R. Henderson.

February 3, Boston, Mass. Subject: Railroad Rolling Stock, Electrical Equipment and Permanent Way, recent developments and present tendencies: papers by Henry Bartlett, Frederic B. Hall, A. B. Corthell.

February 14, Milwaukee, Wis. Subject to be announced.

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THE NEW JOURNAL

The Journal appears this month in an enlarged form, with a new arrangement of its material and new matter added. As already announced, this comes as the result of a long and careful study by the Publication Committee of the whole question of the publications of the Society, made at the request of the Council.

In considering the problem a forward look has been taken into the possibilities of The Journal as the publication of a great engineering society, whose membership is rapidly increasing and whose activities are extending in many directions. These possibilities appear to be very great and the service which may eventually be rendered to the membership almost invaluable. Local meetings of the Society are now held in twelve cities, and the Annual and Spring Meetings are so filled with professional papers that it is necessary to hold simultaneous sessions; while the other active work of the Society has grown to such an extent that its various committees have over 300 names on their rolls. These facts suggest the possibilities in the way of papers, discussion and reports of varied character for publication in The Journal, and the comprehensive way in which the broad field of mechanical engineering is destined to be covered through the resources of the Society alone. Add to these the resources of the Engineering Societies Library, outlined in a separate article in this number, and the opportunity for bringing the library closer to the membership through reviews of its periodical literature, and a suggestion may be had of what The Journal may eventually accomplish for the Society and its members and the cause of mechanical engineering in general.

PLAN FOR THE SOCIETY'S PUBLICATIONS

It has long been evident that the duplicate publication of papers and discussion, first in The Journal and later in Transactions, was an economic waste not in accord with good engineering practice. It is proposed to avoid this duplication by having The Journal contain the Transactions, the material of which will be arranged with this end in view. In this respect the Society will be following the custom of the leading European engineering societies, including the Verein deutscher Ingenieure, and of the American Medical Association in this country. The journals of the Verein and of the American Medical Association are the most successful professional journals in the world.

Under the present plan of publication papers for the Annual and Spring Meetings are to be printed in pamphlet form, complete, in advance of the meeting, but not published in The Journal prior to the meeting. In order that the membership may be advised of the papers that are to be presented, however, abstracts of papers for a coming meeting will be grouped and published in one number of The Journal one month in advance of the meeting, and copies of the complete papers on any subject will be sent gratis to members asking for them.

Papers and discussion will be published together in issues of The Journal following the meeting at which they are presented. By this procedure, the papers and discussion will be brought together instead of being separated as has previously been the case in The Journal. The revised papers and discussion will thus appear at an earlier date than is possible in the annual volume of Transactions, and will constitute the Transactions of the Society in a permanent form for binding and preservation by the membership. While it has not recently been possible to include all the papers and discussion in the annual volume of Transactions owing to the necessity of keeping this publication within the limits of a single volume, The Journal can probably contain all this material and be a complete instead of a partial record of the various meetings of the Society.

THE NEW SIZE FOR THE JOURNAL

The 9 by 12 size which is now adopted for The Journal is the standard toward which the technical journals are tending. Already 144 of the publications received in the Engineering Societies Library are of this size, and many others approximately so. A larger page than the 6 by 9 size heretofore used has been much needed in order to present properly the articles

which have to be handled without the use of the always inconvenient folders and inserts. An example of this is to be found in this number in the report on flanges, which has tables and diagrams that would be altogether too small if reduced to the size of the smaller page.

The larger page also allows a more attractive presentation of the matter; the text can be more easily read because of the narrower columns and the page appears more inviting because there are more text and illustrations under the eye at one time. The Journal in this form will further be more economical to produce because there are fewer units to handle; and it will allow the advertiser a more effective display and so increase the advertising income. All of this income is used for the production of The Journal, absolutely none being spent on Society activities.

Substantially the 9 by 12 size is used by such professional societies of the world as the Verein deutscher Ingenieure and many other leading continental societies; by the Institution of Naval Architects, the American Medical Association and the American Society of Naval Architects; and has recently been adopted by the American Institute of Architects and the Institution of Electrical Engineers of Great Britain. It allows a freer scope in the conduct of a journal and is one of the important elements in its successful production.

REVIEW OF ENGINEERING SOCIETIES

In the present number of The Journal there has been begun a review of the proceedings of engineering societies, in addition to the Foreign Review previously published. The proceedings of 132 societies are received in the library, and much of this material would not be available to the membership except through a review such as is now being undertaken. While it is hoped that this department may be extended and other improvements made in The Journal, the development must necessarily be gradual, and within the available income.

ARRANGEMENT OF THE JOURNAL

As now printed, The Journal is made up in sections which can be readily separated to facilitate binding. The reports of meetings and engineering matter of greatest value for permanent record are contained in two middle sections, each numbered on a different system to avoid confusion in indexing.

The first of these sections contains papers, discussion and reports of meetings, equivalent to what is now included in the annual volume of Transactions, only, as already explained, it will be more complete. This section will therefore constitute an improved Transactions and can be bound up separately as such if desired.

The second section referred to consists of the Foreign Review and the Review of the Proceedings of Engineering Societies, which can also be bound separately, or, if preferred, the twelve review parts of a year's volume can be grouped and bound together at the back of the volume of Transactions.

Two other sections, constituting the beginning and end of the reading pages respectively, are of less permanent value or of a less technical nature. If a member desires to reduce the size of his bound volume to the lowest limit, he can discard these first and last sections without losing any of the essential engineering data. At the end of the year suitable indexes will be issued, with directions for binding.

Referring to the present number, the Transactions part begins with the report of the Annual Meeting, following which is the review part and after that certain miscellaneous matter which many may wish to discard. At the very front is other miscellaneous matter among which is a report on Flanges, which was not included in the Transactions part because it is to come up again for further discussion and so is subject to revision.

COPIES SHOULD BE SAVED FOR BINDING

Every member of the Society should keep his copies of The Journal for binding at the end of the year. The Journal now comprises the only complete record of the Society's affairs. While a volume of Transactions will be issued this year as usual, to contain the papers and discussion for the year 1913, it is intended thereafter that The Journal shall take the place of Transactions and in order to insure the continuity of the bound volumes all the copies of The Journal for the present year should be saved for binding. As a personal matter, if a sufficient number of members express a desire for copies of Transactions in the original form with the small page, an edition will be printed and sold at cost.

NEW OFFICERS OF THE SOCIETY

JAMES HARTNESS

President of the Society for 1914

James Hartness, President of The American Society of Mechanical Engineers for the year 1914, was born in Schenectady, N. Y., in 1861. The first twenty years were spent at Cleveland, Ohio, where after graduating from the public schools he began practical work in machinery building plants. For the next three years he held a position as foreman of a manufacturing plant in Winsted, Conn., and for the four years following, was with a hardware manufacturing plant in Torrington, Conn., where he finally served as inventor.

In the fall of 1888, Mr. Hartness designed machinery for the Jones and Lamson Machine Company at Springfield, Vt., and shortly afterward took an active part in the management of this company. He served successively as superintendent, manager and, for the last dozen years, as president. During this period he has become one of the most prominent manufacturers in New England and one of the most widely known engineers in the country, particularly in the machinery building industry, through the invention and manufacture of the Flat Turret Lathe and of various other machines and tools for turning metal. The fundamental idea in these machines has been to produce certain kinds of work, generally classed as engine lathe work, with greater expedition and economy than could be accomplished with the engine lathe. He has taken out in all over eighty American patents on his various inventions.

The Jones and Lamson Machine Company with which Mr. Hartness' engineering success has been associated, was formerly the old Robbins and Lawrence Company, started at Windsor, Vt., over sixty-five years ago. They originally built a general line of machine tools, but gradually specialized on turret lathes, so that the history of this firm appears to be practically the history of the turret lathe itself from its very beginning. Various features now in common use were developed from time to time until about 1882 when the turret lathe had practically become standardized in the form of the present high turret machine of commerce with the various features of power-feed, lever-operated back gears, etc., and was being built in sizes that were very large for those times. It was then tending to find its work in the engine lathe field rather than in strictly screw machine work.

The turret lathe remained stationary in its development at this point for several years, until Mr. Hartness' connection with the concern which began in the fall of 1888. He at once saw the possible development of the turret lathe, and inaugurated a series of improvements which brought it into the field of bar and shaft work of a kind that had previously been considered engine lathe work pure and simple.

In studying the problem he considered the merits of three forms of turrets,—the disk turret, the barrel turret, and the flat turret. He found that the disk turret had been anticipated by the Gray turret lathe built on a small scale some years previously in Alabama. He patented the barrel turret, but did not consider it as the most practical form for use in the hands of workmen with no especial training for the machine. The flat turret appealed to him as meeting the requirements in a practical way for a broad extension of the turret lathe field, making possible the turning of long pieces, such as shafts and spindles, etc., from the bar with an accuracy and rapidity not previously possible. The form of the turret permitted a firm tool surface on which the specialized turning tools could be clamped; and what was especially important, permitted the locating of the locking pin directly under the cutting tool, instead of on a very much smaller diameter, as with the old-fashioned form of turret. The turret was also gibbed at the outside on a larger diameter than the location of the cutting tools.

The tools themselves were of original construction, embodying principles now universally used in all turret lathes for doing bar work. The principal feature of the improvements was the provision of adjustable blades and back rests in the same holder to which the severe strains of cutting were thus confined without permitting deflection and lack of truth, even in turning of the most slender variety.

One interesting feature of Mr. Hartness' first work on the flat turret lathe may be mentioned. He was working on a certain important detail of turret lathe construction, and after a long study had settled on a certain form of mechanism as being the logical construction. In looking through the archives of the firm, he found a sketch of the identical mechanism made many years previously by Mr. Fred Howe, who was the mechanical genius mainly responsible for the splendid line of original design brought out in the early history of the firm. After the first natural feeling of disappointment, Mr. Hartness took courage from the thought that he had come to the identical conclusions reached by this thoroughly skilled and original mechanic of an earlier generation, and so continued his work in the development of what is now the flat turret lathe.

For several years Mr. Hartness has had as one of his pleasures the study of astronomical subjects and in 1910 he invented the turret equatorial telescope, which had as its very practical object the protection of the astronomer engaged in making observations from the

rigors of a cold winter climate. This end was attained without the serious optical loss that had been involved in previous designs, and is generally considered a marked step in advance which will have an important bearing on the results obtained by astronomers when working under severe climatic conditions. One of these instruments was built, and erected at his residence at Springfield, Vt., and formed the subject of a paper before the Society at the Annual Meeting of 1910.

As all of Mr. Hartness' friends and acquaintances know, he is a man of strong individuality, which shows in everything his hand touches. The machines he has designed could have been designed by no one else. They will be mistaken by no one for the work of another designer. The same applies to the business organization and methods of management of the firm of which he is the head. Many of these ideas have been set forth at some length in his book, the Human Factor in Works Management.

Previous to his election to the presidency of the Society, Mr. Hartness was a vice-president and in the absence of President W. F. M. Goss served in the capacity of president during last summer's trip through Germany. In every city visited he was called upon to address the German and American engineers.

Mr. Hartness became a member of The American Society of Mechanical Engineers in 1891. He is a fellow of the American Association for the Advancement of Science, and a member of the Institution of Mechanical Engineers, the Verein deutscher Ingenieure, the Astronomical and Astrophysical Society of America, the London Astronomical Society, the Royal Arts Society, the Boston Chamber of Commerce, and is a vice-president of the Western New England Chamber of Commerce. He was granted an honorary degree of M. E. by the University of Vermont in 1910.

NEW MEMBERS OF THE COUNCIL

At the Annual Meeting the following new members of the Council for 1914 were elected: Vice-Presidents, Henry L. Gantt, E. E. Keller, H. G. Reist; Managers, A. M. Greene, Jr., John Hunter, Elliott H. Whitlock.

HENRY L. GANTT

Henry L. Gantt was born in Calvert County, Md., on May 20, 1861, and was graduated from Johns Hopkins University in 1880 with the degree of A.B. He then taught school for three years and took the degree of M.E. at Stevens Institute of Technology in 1884. He was connected with Poole & Hunt, Engineers and Machinists, in Baltimore, as draftsman, and conducted an extensive study of investigations to determine the cost of irregular melting of cast-iron in foundry cupolas. He was with the Midvale Steel Company, Philadelphia, for six years, and subsequently held positions as superintendent of the American Steel Casting Company and the Simonds Rolling Machine Company, and was later with the Bethlehem Steel Company and the American Locomotive Company.

Since 1903 he has been in consulting practice, engaged in introducing shop management methods. This work which has become his specialty actually began in 1887 when he was engaged at the Midvale Steel Works, under F. W. Taylor, studying the laws of cutting metals, and reducing them to curves by which he was able to make instructions and set piece rates for cutting steel.

In 1899 he took up the same work with Mr. Taylor at the Bethlehem Steel Works, and put these laws on a slide rule, making them more readily available for giving instructions and setting tasks for cutting steel. In 1901 he devised the system of task work with a bonus, and at the Annual Meeting of the Society in that year read his paper on a Bonus System of Rewarding Labor.

The results of this system far exceeded all anticipation. Working at a task with a reward for its accomplishment seems to have a psychological effect when the task is within the workman's reach, and stimulates a much greater interest than piecework does, with a corresponding benefit to both employer and employee.

For the past few years Mr. Gantt has been engaged in perfecting a system of management which would lead employees of all grades to become interested in their work. One result has been the development of a strong spirit of harmony and coöperation among employees working under his instructions, but which is so strong as almost to eliminate jealousy among those engaged in the work. The most striking effect, apart from the improvement in quality and increase in quantity of product, has been the development and training of men. It is seldom now in plants working under these methods that a trained man promoted to a higher position does not fill it better than his predecessor did.

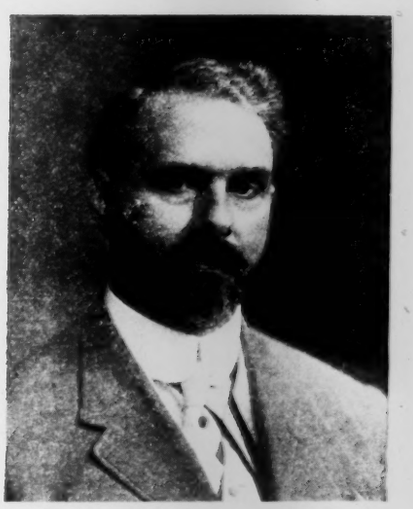
Mr. Gantt has presented a number of papers on his work before this Society and others, the principal ones being that mentioned on a Bonus System of Rewarding Labor; A Graphical Daily Balance in Manufacture, read before the Society in 1903; and Training of Workmen, read in 1908. He is also the author of Work, Wages and Profit, published in 1910, and which has recently been enlarged in a new edition.

While at the Bethlehem Steel Works Mr. Gantt developed an armor-piercing projectile and established its manufacture. After an extensive series of experiments on a laboratory scale, he produced four 8-inch projectiles, all of which passed the Government tests. No projectile submitted for test failed to pass it.

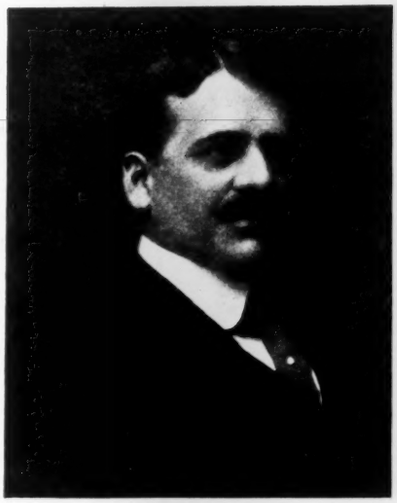
E. E. KELLER

E. E. Keller was born in New York City on October 16, 1863, and was educated in the New York and Rochester public schools, where his parents removed when he was seven years old. On leaving school he obtained employment with the Yawman & Erbe Com-

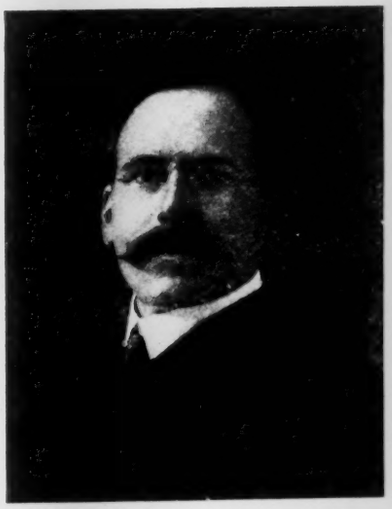
HENRY L. GANTT, VICE-PRESIDENT



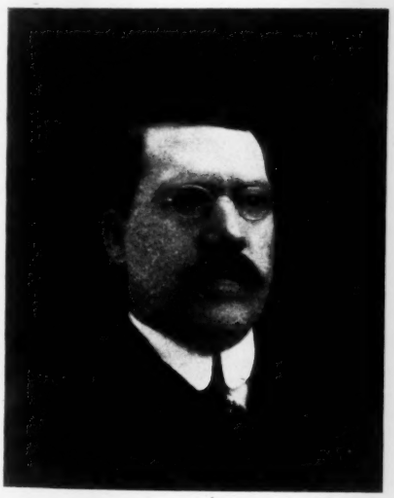
E. E. KELLER, VICE-PRESIDENT



A. M. GREENE, JR., MANAGER



H. G. REIST, VICE-PRESIDENT



JOHN HUNTER, MANAGER

ELLIOTT H. WHITLOCK, MANAGER

pany, studying mechanical and electrical engineering in his spare hours.

In 1888 he entered the employ of the Westinghouse Company in Pittsburgh, and within three months was given charge of all the construction work in the Pittsburgh district. Three months later he was made manager of the Chicago office and placed in charge of the construction work of that district. At the beginning of the work on the World's Columbian Exposition in 1891 he received the appointment of electrical engineer for the department of electricity of the exposition commission, carrying this in conjunction with his other work.

In July, 1892, he gave up this special work for the exposition in order to devote all his time to the work to be done under the contract secured by his company for the lighting of the buildings, exhibits and grounds of the fair, the largest single electric lighting construction contract ever undertaken up to that time, with only a little more than a year's time in which to complete the work. It included all the installation of plant, underground and interior work, decorative lighting, and the operation before, during and after the exposition period, as well as the final removal and disposal of the installation. Mr. Keller's marked success in this work resulted in his being offered the position of vice-president and general manager of the Westinghouse Machine Company, then a comparatively small organization building single acting steam engines only.

In 1895 Mr. Keller went to Europe to investigate the steam turbine and bought the United States patents and rights covering the Parsons steam turbine for his company. The following year he began the construction of the present large plant at East Pittsburgh to take care of increased business and the construction of steam turbines and gas engines, which during the fifteen years in which he occupied the office of vice-president and general manager expanded the business to its present large proportions.

In 1907 he was made one of a board of receivers for the Westinghouse Machine Company and carried on the active executive management for the receivers until the property was returned to the stockholders in March, 1908. Mr. Keller severed his connection with the several Westinghouse interests in 1908, and began to devote his time to his personal interests in Detroit and elsewhere.

He organized the Detroit Insulated Wire Company, of which he became its president in 1906, and three years later removed to that city in order to look after the interests of the company and those of the Metal Products Company, of Detroit, of which he was also president. Both companies soon became successful, but owing to the pressure of other interests, Mr. Keller severed his connection with them some time ago. He is now actively connected with several other manufacturing enterprises of Detroit and elsewhere, which, however, are of lesser importance.

Mr. Keller is a member of the American Institute of Electrical Engineers and of the Verein deutscher Ingenieure, as well as a member of other engineering and technical societies.

HENRY G. REIST

Henry G. Reist was born near Mt. Joy, Lancaster County, Pa., May 27, 1862, and received his technical education at Lehigh University, from which he was graduated in 1886 with the degree of M. E. The same year he entered the employ of the foundry and machine department of the Harrisburg Car Company, and was engaged in the manufacture of Ide engines and road rollers. After a year of testing and erecting steam engines, he became assistant superintendent.

He went abroad with the Society in 1889, and upon his return became associated with the Thomson-Houston Electric Company, at Lynn, Mass., advancing in a few months to the position of foreman of the winding and testing department. Soon after the formation in 1894 of the General Electric Company, successor to the Thomson-Houston Electric Company, he took charge of the design of alternating-current generators and motors for that company, and at present occupies the position of mechanical engineer for the same firm.

Mr. Reist helped to develop the first large belt-driven railway generators, and for about fifteen years has been identified with the design of alternating-current machinery. Much of the largest and most important electrical machinery has been designed under his direction. He is a member of the American Institute of Electrical Engineers, and of several other technical organizations.

ARTHUR M. GREENE, JR.

Arthur M. Greene, Jr., was born in Philadelphia, Pa., February 4, 1872, and was educated in the public schools of that city, and at the University of Pennsylvania, from which he was graduated with the degree of B. S. in 1893 and with that of M. E. in the following year. During his college course he was the recipient of a number of honors.

In 1893 he took charge of the apprentice school of the Franklin Sugar Refinery, and the following year became an instructor in Drexel Institute, receiving an appointment in the department of mechanical engineering of his alma mater in 1895. He remained in this work until the year 1902, when he resigned to become professor of mechanical engineering and later junior dean of the school of engineering of the University of Missouri. In 1907 he came to the Rensselaer Polytechnic Institute in Troy as professor of mechanical engineering, the position he now occupies.

Professor Greene has been active in his profession in various lines. He was a member of the committee of science and the arts of Franklin Institute from 1895 to 1902, was mechanical engineer for the National Export Exposition in Phila-

delphia in 1899 and a member of its jury of awards, and made the original plans for the equipment of the new mechanical engineering laboratory of the University of Pennsylvania. His work at the University of Missouri included charge of the mechanical engineering equipment of the new laboratories, and he was also in charge of the power plant and maintenance department. At Rensselaer he has also supervised the new laboratories.

He is an expert in court and patent cases, and is the author of several books on heating and ventilation, pumping machinery and steam engineering. He is a fellow of the American Association for the Advancement of Science and is now president of the Society of Engineers of Eastern New York.

JOHN HUNTER

John Hunter was born in Scotland in 1866 and was educated in the public schools, serving his apprenticeship as a mechanical engineer before leaving Scotland.

The first twenty years of his career were spent in marine service. In 1885 he joined the Red Star Line, S. S. Westerland, as junior engineer, sailing between Antwerp and New York, rising to first assistant of the S. S. Friesland of the same company in 1891. In 1895 he transferred to the new S. S. St. Louis of the American Line, running between New York and Southampton, as senior first assistant engineer, and at the outbreak of the Spanish-American war in 1898 was appointed chief engineer of the S. S. St. Paul with the rank of lieutenant, U. S. A.

The St. Paul was taken over by the United States Navy, equipped as an auxiliary cruiser, and fitted with twenty 5-inch guns, and under the command of Admiral Sigsbee saw much active service during the war, which bore heavily on the crew. When the St. Paul went back in the North Atlantic service, Mr. Hunter continued as chief engineer until August 1905 when he gave up his naval career to enter consulting work. During his twenty years of sea service he had traveled 1,500,000 sea miles, and had seen an interesting development in marine engineering. The steam pressure carried on boilers in his ships had risen from 10 to 200 pounds, and the old low-pressure engines had given place first to the cross-compound type, with 80 pounds pressure, then to the triple expansion three-cylinder engine with 165 pounds, and finally to the six-cylinder quadruple expansion engines and twin screws of the St. Paul, with their 200 pounds pressure.

In August, 1905, he went to St. Louis to take the position of chief engineer of the power plants of the Union Electric Light and Power Company. At that time the Ashley Street plant was under construction, and changes were being made to increase the capacity of the station. In the early part of 1907 he was given charge of the construction work of the company and the completion of this plant, including the last section of the east river wall where it was found necessary to sink two caissons to bed rock, 22 feet below the zero stage of the river. He is also in charge of the steam heating plant of the company.

Mr. Hunter has been prominent in the affairs of national societies, having served for three years as a member of the prime movers committee of the National Electric Light Association, and is now president of the Engineers Club of St. Louis. He also served two years as president of the Caledonian Society.

ELLIOTT H. WHITLOCK

Elliott H. Whitlock was born in Brooklyn, N. Y., on May 5, 1867, and after attending the public schools entered the mechanical department of the State College in Texas, where his brother was a professor of mechanical engineering. He was graduated with the degree of B. S. in 1886, and in the fall of the same year entered Stevens Institute of Technology, receiving the degree of M. E. in 1890.

Mr. Whitlock's first work was with the Pennsylvania Railroad Company, in their motive power department, as a special apprentice in the Columbus, Ohio, shops. He left this position in 1891 to occupy the chair of mechanical engineering at the State Agricultural and Mechanical College in Brookings, S. D., remaining until 1893 when he entered the employ of the Williamsburg Gas Light & Coke Company of Brooklyn. He subsequently was with the United Gas & Improvement Company of Philadelphia, in their construction department, and manager of the New York Oxygen Company, New York City.

About this time Mr. Whitlock engaged in retail business in Cincinnati, acting as president of a concern handling gas appliances. That his interests were still along mechanical lines, however, is evidenced by the small ice machine which he developed incidentally during this period. He was for a short time manager of the King Axle & Tool Company of Cleveland, and in 1896, connected himself with the National Carbon Company, of which he is at present factory manager.

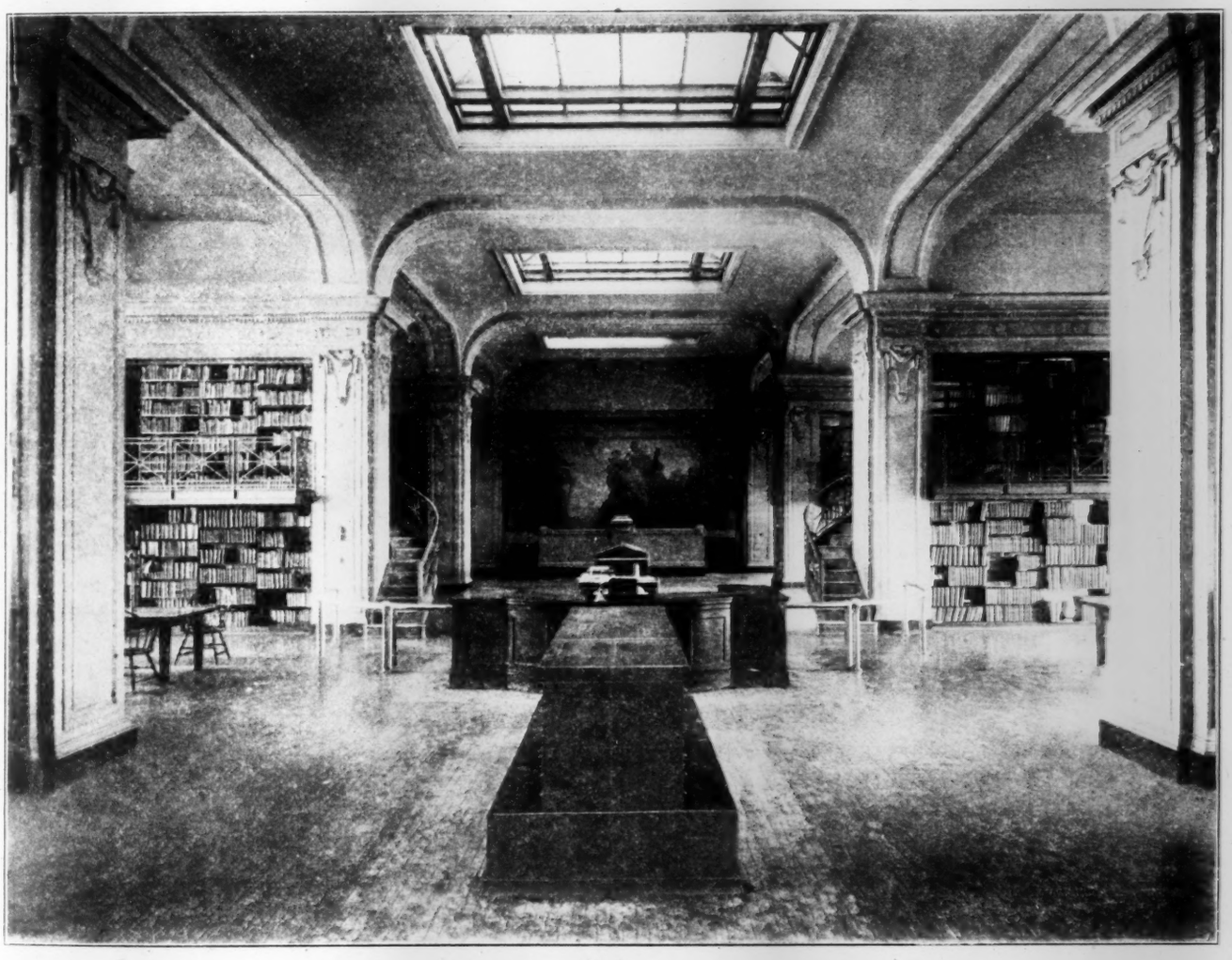
Mr. Whitlock has had a patent issued on an improvement on a drop hammer and also one on a new type of oil gas retort using vertical cast-iron retorts. The development of this latter idea led Mr. Whitlock to construct a plant which is still in operation.

THE ENGINEERING SOCIETIES LIBRARY

ONE of the largest collections of engineering literature in the world is housed in the Engineering Societies Building, at 29 West 39th Street, New York, the headquarters of The American Society of Mechanical Engineers. It is made up of the joint libraries of the American Institute of Electrical Engineers, The American Society of Mechanical Engineers, and the American Institute of Mining Engineers, and contains more than 65,000 volumes of great technical value, including, besides all the important works in these three fields of engineering, many books of reference, the bound sets of the proceedings of practically all the engineering societies of the world in these fields, and of many others allied with them. Some of these sets cannot be found in complete form in any other library in the country.

The library also receives every important engineering periodical of the world in the mechanical, electrical and mining fields, as well as many others covering chemical technology and other allied industries, numbering in all more than 700 current magazines, printed in more than ten languages, which are now at the disposal of the reader.

The location of the library at the top of a great building is almost ideal, insuring as it does splendid lighting and the absence of dust and street noises. Its arrangement was planned with a view to making its contents accessible to readers, and only a few of the greater rarities are in locked cases, all the other volumes being on open shelves. Those most frequently called for are in the main reading room on the top floor, while the stack room on the floor below contains the ones less seldom referred to.



The main reading room, a photograph of which is shown herewith, is dignified in its simplicity. Three massive columns on each side separate the north and

south sides into spacious alcoves, where wide tables and comfortable chairs have been placed for the convenience of the reader. The mezzanine gallery recently erected, has increased the shelf space, and adds to rather than detracts from the general appearance. At the rear of the room, facing the visitor as he enters, is Frank Dana Marsh's fine mural painting depicting the operations of engineering. The central figure is that of the directing engineer, robust and keen-eyed, while on each side are brawny workmen handling machinery, drilling hard rock, running surveying lines, and erecting dynamos. In the background are railroads, bridges, blast furnaces, steel works—a Pittsburgh in miniature. A fine view of New York and its massive skyline can be obtained from the wide windows of the reading room.

Through the generosity of the members of the three societies which jointly maintain the library, supplemented by the annual appropriations of the societies of themselves, there has been accumulated this collection of technical literature of exceptional value. Among the volumes available are the publications, in their original editions, of the two oldest learned societies of the world, the Royal Society of London and the Academy of Science of Paris, the former dating from the time of Charles II of England. Electricity and magnetism are completely covered by the Latimer Clark Collection, presented in 1901 by Dr. Schuyler Skaats Wheeler, and through the kindness of Dr. Carnegie properly catalogued and housed. The great works of the mathematicians, physicists and chemists which are the basis of all engineering, are well represented.

The early work of the engineer is represented by many valuable works dating back to the beginning of the printing of scientific books, and the many volumes in Latin and mediaeval English form a nucleus of what, it is hoped, may in the future be a valuable source of information for the American engineer interested in the history of his profession.

But, however great may be the value of old books, the engineer of today wants the literature of today. The library is not a dry-as-dust museum. It has records of the past for reference when required, but it has in even greater profusion the literature of the immediate present. Every engineering periodical is accessible to readers as quickly as the mail can bring it to the library, and books are usually available before they reach the review columns of the engineering journals. Every work is catalogued and shelved as promptly as possible.

Through the gift of a lately deceased member of The American Society of Mechanical Engineers, the library has acquired one of the most complete collections in the world of works on machinery and appliances for handling and conveying materials of all kinds, and this collection is being expanded as rapidly as possible. In these days of large enterprises the literature of this subject is of enormous importance. An attempt is being made to cover every subject of contemporary interest in the same complete manner.

The 700 serial publications received from all parts of the world are for the most part preserved and bound. These are largely received in exchange for the publications of the founder societies. A list has been issued by the library showing the periodical sets which it contains, and a second list, in which will be shown the resources of seven libraries in New York and its vicinity, is being edited for publication. It is hoped that ultimately a list covering the libraries of the United States may be issued.

It is manifestly impossible for any engineer to collect, preserve and digest for himself the voluminous literature of his profession. He must depend on the work of others, reviewers, indexers, abstractors, and librarians. Until a very recent date a library considered its duty accomplished when it had acquired, preserved, catalogued, and indexed the literature of the subjects covered. A reader was forced to visit a library in order to get information. But the up-to-date library is adopting a new policy which makes complete service possible to students at a distance.

To be more specific, the library of the Engineering Societies is prepared to render the following service to any one who desires it:

(a) It will verify references, furnish abstracts, copies, and translations of any article from citations sent by an engineer or student.

(b) It will furnish partial or complete bibliographies of engineering subjects, and where the original sources are not available to the client, furnish either the original print, or such abstracts, copies, photographs and translations as are necessary.

During the period in which this service has been in operation, some 500 reference lists have been compiled, and copies have been retained and are available to any one. It is manifestly impossible to give here a complete list of the subjects covered; it can only be said that nearly the whole engineering field is covered. A list covering such a search on the subject of Pulverized Fuel is printed in this issue of The Journal. The library keeps a card index of the important articles in the current periodicals and society publications as it receives them, so that the inclusion of the literature of the minute is assured in the reference lists.

This special service is particularly commended to the attention of engineers in isolated places. Its international scope is evidenced by the fact that during the past two years it has been of assistance to engineers in such far-off countries as Patagonia, Korea, Japan, South Africa, Germany, and Australia. References have also been sent to Alaska, British Columbia, Mexico, and the Canal Zone. In the improbable event that a reference is not found in the library,

books are borrowed from other libraries, either in New York or other cities. When transcripts of articles are desired, photographic copies are preferable in most cases, as being cheaper than typewriting and a guarantee against mistakes.

The library is a general bureau of information for engineers. It will furnish addresses of engineers, names of publishers of books and periodicals, addresses of manufacturers, and statistics of various kinds. It also has facilities for accurate technical translation. Requests by telephone, telegraph and cable will receive immediate attention.

A nominal charge (net cost) is made for this service, based on the following rates: for research or copying, fifty cents per hour; for translations, twenty-five cents per one hundred words for French and German, and thirty-five cents for other European languages. Photographs, made white on black, direct on paper, cost thirty cents for each 11 in. by 14 in. sheet, which may cover two opposite pages either full size or reduced.

The relation of the library and the engineer should be a reciprocal one. The engineer may help the library and his fellow engineers in several ways. He may give books, or money to buy them; he may send trade catalogues, maps and blueprints. He may suggest new books for purchase. If he wishes to indulge in adverse criticism, he should direct it to the librarian, who welcomes suggestions of improvement, even if unpleasantly critical. The library is the property of the engineer, and not of the librarian, and the librarian can best serve the engineer who knows what he wants, makes it specifically known, and complains specifically and directly of disappointments.

W. P. Cutter, *Librarian*

COUNCIL NOTES

At the meeting of the Council on December 5, the following committee on meetings in San Francisco was approved: Robert Sibley, Chairman; Thomas Morrin, Vice-Chairman; C. T. Hutchinson, Secretary; E. C. Jones and C. R. Weymouth.

The Secretary read a letter from Dr. Charles E. Lucke, recommending the appointment of engineers to commissionerships in national, state and municipal departments involving engineering work, and a resolution was passed by the Council approving the suggestion and also the recent action of the American Institute of Consulting Engineers favoring such appointments. The matter was then referred to the Joint Conference Committee for further action.

The following were appointed to act as a Committee on Standardization: Henry Hess, Chairman; J. H. Barr, Charles Day, C. J. Davidson and Carl Schwartz. A resolution was passed by the Council to amend the Constitution to make the committee on standardization a Standing Committee.

At the meeting of December 5, Calvin W. Rice and Frederick R. Hutton were reappointed respectively Secretary and Honorary Secretary of the Society, and E. B. Katte was elected Vice-President to fill the unexpired term of James Hartness. The following Executive Council was appointed: James Hartness, Chairman; Alex. C. Humphreys, Vice-Chairman; E. D. Meier, H. L. Gantt, E. B. Katte, Alfred Noble, and H. G. Stott. Dr. Alex. C. Humphreys was reappointed trustee of the United Engineering Society, and Ambrose Swasey chosen as the representative of the Society on the John Fritz Medal Board of Award.

The Council was addressed at this meeting by a representative of the Verein deutscher Ingenieure, Geheimrath Fr. Romberg, on the solution of important questions in technical and industrial education. His offer, on behalf of the Verein, to present a set of volumes covering that organization's report on technical schools was accepted with thanks.

Calvin W. Rice, *Secretary*

APPLICATIONS FOR MEMBERSHIP

Members are requested to scrutinize with the utmost care the following list of candidates who have filed applications for membership in the Society. These are sub-divided according to the grades for which their age would qualify them and not with regard to professional qualifications, i. e., the age of those under the first heading would place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, while those in the third class are under twenty-five years of age and therefore qualified for Junior grade only. The Membership Committee and in turn the Council urge the members to assume their share of the responsibility of receiving these candidates into the membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. Members will be furnished with complete records of any candidate thus questioned. All correspondence in regard to such matters is strictly confidential and is solely for the good of the Society, which it is the duty of every member to promote. These candidates will be balloted upon by the Council unless objection is received before February 10, 1913.

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Allen, Frank L., Rep., Marshall & Huschart Mchy. Co., Chicago, Ill.

Anderson, Arthur H., Asst. Prof., Mech. Engrg., Armour Inst. of Tech., Chicago, Ill.

Arnold, Henry F. W., Plant Engr., The Jeffrey Mfg. Co., Columbus, Ohio

Bates, James H. S., Cons. Engr., 118 P. O. Box, Hoboken, N. J.

Bird, Frederick J., Engr., Link-Belt Co., Chicago, Ill.

Blanding, Forrest H., 1300 College Ave., Racine, Wis.

Boomhower, Frederick K., Ch. Engr., Insurance Exch. Bldg., Chicago, Ill.

BUCKINGHAM, EDGAR, Assoc. Physicist, Bureau of Standards, Washington, D. C.
BUNTON, F. L., Dist. Mgr., Heine Safety Boiler Co., Chicago, Ill.
BURROW, EDGAR A., Ch. Engr., San Angelo Water, Light & Power Co., San Angelo, Texas
CLARK, LAWRENCE A., Secy. and Treas., Archer Iron Wks., Chicago, Ill.
CONVERSE, WM. A., Secy. and Chem. Dir., Dearborn Chemical Co., Chicago, Ill.
COOPER, FREDERICK F., Genl. Mgr., Golden States & Miners Iron Wks., San Francisco, Cal.
COX, ABRAHAM B., Asst. Engr., General Reduction, Gas & By-Products Co., 49 Wall St., New York
DEWOLF, ROGER D., Mech. Engr., Rochester Rwy. & Lt. Co., Rochester, N. Y.
EHRHART, RAYMOND N., Engr., Westinghouse Mch. Co., E. Pittsburgh, Pa.
ERDELL, WILLIAM E., Pres. & Genl. Mgr., Penn-Allen Cement Co., Allentown, Pa.
FORTUIN, MORRIS, Wks. Mgr., Pennsylvania Cement Co., Bath, Pa.
GAYMAN, BERT A., Asst. Ch. Engr., Link-Belt Co., Chicago, Ill.
GOETTSCH, JULIUS, Asst. Genl. Supt., D. H. Burnham & Co., Chicago, Ill.
GRADY, CHARLES B., Asst. Mech. Engr., N. Y. Edison Co., New York
GUSTAFSON, LEWIS, Supt., David Ranken, Jr. Sch. of Mech. Trades, St. Louis, Mo.
HART, CHARLES F., Mech. Engr., Assoc. Newspapers, Ltd., London, England
HAWKINS, THOMAS U., Master Mech., Mutual Chem. Co. of Amer., Jersey City, N. J.
HILL, GEORGE F., Engr. & Contr., 15 E. 40th St., New York
JOHNSON, WILNER E., Engr., Car Constr., N. Y. Municipal Rwy. Corp., Brooklyn, N. Y.
KAMMANN, FRANZ, Ch. Engr., Briegleb, Hansen & Co., Gotha, Germany
KARL, ROBERT H., Asst. Supv. Engr., Anheuser Busch Brewing Asso., St. Louis, Mo.
KNOBLOCH, ALVIN F., Vice-Pres. and Genl. Mgr., Northway Motor & Mfg. Co., Detroit, Mich.
MCCAULEY, LOUIS G., Mech. Engr., The Fairbanks Co., Binghamton, N. Y.
MORRIS, ALBERT W., Cons. Engr., A. W. Morris & Co., Philadelphia, Pa.
NEWCOMB, FRANKLIN L., Special Apprentice, M. P. Dept. Lake Shore & Mich. Southern Rwy., Cleveland, Ohio
NYGREN, WERNER, Member of Firm, Nygren, Tenney & Ohmes, Cons. Engrs., New York
PARK, WM. M., Combustion Engr., Green Engineering Co., Chicago, Ill.
POOL, JOHN F., Supt. Amer. Sugar Refining Co. of N. Y., Brooklyn, N. Y.
ROSE, CLARENCE E., Mgr., Merchants Light Co., V.P. & Genl. Mgr., Arkansas Cold Storage Co., Little Rock, Ark.
SAYERS, ALBERT J., Charge of Coal Washery and Mining Depts., Link-Belt Co., Chicago, Ill.
SHAAD, GEORGE C., Prof. of Elec. Engr., Univ. of Kansas, Lawrence, Kansas.
SHAW, JAMES W., Constr. Dept., Allis-Chalmers Mfg. Co., New York
SHIMMIN, ROBERT P., Salesman, Link-Belt Co., Chicago, Ill.
SPEAR, GRANT W., Vice-Pres. and Eastern Mgr., Dearborn Chemical Co., New York
STONE, LOUIS L., Vice-Pres., Hunt Engrg. Co., Medicine Hat, Alberta, Canada
TALBOT, ARTHUR N., Prof. of Municipal and Sanitary Engrg., University of Illinois, Urbana, Ill.
THOMPSON, HENRY P., Sales Engr., Harrison Safety Boiler Wks., Southern Ohio and Kentucky
WARDENBURG, FREDERIC A., Directing Engr., E. I. duPont de Nemours Powder Co., Wilmington, Del.
WARREN, JOHN B., Asst. Genl. Mgr., Philadelphia Steel & Forge Co., New York
WOHRA, HAR DAS, Student, State Univ. of Arkansas, Fayetteville, Ark.
YATES, PRESTON K., Cons. Engr., 30 Church St., New York

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

BEERS, ROYCE L., Junior Fuel Engr., U. S. Bureau of Mines, New York
BEST, JESSE L., Ch. Engr., So. Illinois Lt. & Pwr. Co., Hillsboro, Ill.
BIGELOW, PIERREPONT, Asst. Treas., The Bigelow Co., New Haven, Conn.
BUTLER, NATHAN R., Asst. to Mgr., Jeanesville Iron Wks. Co., Hazleton, Pa.
CASPARIS, KENNETH E., Asst. Genl. Mgr., The Casparis Stone Co., Columbus, Ohio
FINE, BERNARD M., Draftsman, Standard Roller Bearing Co., Philadelphia, Pa.
FISH, MATTHEW R., Cost Estimator, Amer. Steel & Wire Co., Worcester, Mass.
GATES, GRANDON D., Mech. Engr., A. Y. McDonald Mfg. Co., Dubuque, Iowa
HANDS, ROLAND C., Engrg. Dept., Bridgeport Brass Co., Bridgeport, Conn.
IRVIN, RICHARD, Member of Firm, Irvin & Witherow, Engrs., Pittsburgh, Pa.
OSGOOD, WENTWORTH H., Ensign, U. S. Navy, care U. S. S. Eagle, New York
PARMELY, J. CLYDE, Engr., Kewanee Light & Power Co., Kewanee, Ill.
POWERS, ALFRED R., Prof. of Elec. Engrg., Clarkson College of Tech., Potsdam, N. Y.
PRINGLE, NELSON S., Engr. of Tests, Autocar Co., Ardmore, Pa.
ROSENBAUM, HERBERT H., Cons. Engr., Ruebel & Wells Cons. Engrs. Co., St. Louis, Mo.
SHEPARD, HAROLD O., Engr., Quigley Furnace & Foundry Co., New York
THAYER, HOWARD C., Draftsman, M. P. Dept., Interborough Rapid Transit Co., New York.
WANDEL, CARLETON, Special Apprentice, Pennsylvania Railroad, Altoona, Pa.

FOR CONSIDERATION AS JUNIOR

ANDERSON, ARVID R., Elec. Engr., Jeffrey Mfg. Co., Columbus, Ohio.
BOWES, LAWRENCE C., Steam Expert, Inland Steel Co., Indiana Harbor, Ind.
BOYLE, JAMES F., With F. B. Gilbreth, Inc., New Haven, Conn.
BURRAGE, CHARLES W., Asst. in Mech. Engrg., Mass. Inst. of Tech., Boston, Mass.
CATLAND, RAYMOND O., Student, Throop College of Technology, Pasadena, Cal.
DE REVERE, ARTHUR W., Sales Engr., Heine Safety Boiler Co., Chicago, Ill.
GOODRICH, E. RAYMOND, Asst. Engr., Wheeler Condenser & Engrg. Co., Carteret, N. J.
MCEVOY, WALTER C., Engr. for Walter Kidde, Constr. Engr., New York
MEDER, ARTHUR, Asst. Mech. Supt., Individual Drinking Cup Co., New York
SELLMAN, NILS T., 83 West 115th St., New York
SHANDLEY, JAMES G., Draftsman, M. P. Dept., Interboro R. R., New York
SHEAHAN, THOMAS W., Draftsman, Nelson, Brennan, Peterson, Auto Mfrs., Detroit, Mich.

TRANSFER FROM ASSOCIATE

KEITH, ROBERT R., Asst Supt., Sheffield Car Co., Three Rivers, Mich.
LOWE, HENRY L., Ch. Engr., Natl. Light & Power Co., St. Louis, Mo.
MILLSPAUGH, WM. H., Pres., Sandusky Fdy. & Mch. Co., Sandusky, Ohio

PROMOTION FROM JUNIOR

PAYSON, T. ELLIOTT, Genl. Supt. and Mech. Engr., The Seneca Falls Mfg. Co., Seneca Falls, N. Y.

PROMOTION FROM ASSOCIATE-MEMBER

AULL, JEROME J., Mech. Engr., The Lunkenheimer Co., Cincinnati, Ohio

SUMMARY

New applications	78
Transfer from Associate	3
Promotion from Associate-Member	1
Promotion from Junior	1
Total	83

REPORT OF THE COMMITTEE ON INCREASE OF MEMBERSHIP

During the fiscal year, ending September 30, 1913, 1046 applications were obtained. This is a gain of 263 applications or about 33⅓ per cent over that of the preceding year.

As a result of this work the Society elected 842 new members, made 87 promotions and had a very substantial list of applications awaiting the action of the Membership Committee.

This increase of members has resulted in increasing the income of the Society for the year by $30,560. The total expense of your Committee for the year was $3,802.55, or about 12½ per cent of the receipts. This is very low when compared with similar figures from other societies. Some organizations report that to get a new member they spend about one-half of the first year's receipts.

Last year the Committee reported that in the ten months of its existence it had secured 783 applications which makes a total of 1815 applications obtained in a little less than two years' time. The number of applications received this year is approximately the same as the total number received in the three years prior to the appointment of this Committee.

As a result of several joint meetings held by the Membership Committee and the Committee on Increase of Membership in the fall of 1912, a new grade of membership was recommended which went into effect at the Spring Meeting held in Baltimore last May. This grade, known as that of Associate Member, aims to provide a place for those engineers over 25 years of age who have really accomplished something in engineering work and are, therefore, entitled to more recognition than the grade of Junior gives. Amendments to the Constitution presented at the 1913 Annual Meeting make 27 years the minimum age for the Associate Member, and for the grade of Member 32 years the minimum, with ten years experience in engineering work.

The year has seen the development of fourteen subcommittees of the Increase of Membership Committee located in important engineering centers of the country. Those thus far appointed and their chairmen, are:

Atlanta, Park A. Dallis	New York, J. A. Kinkead
Boston, A. L. Williston	Philadelphia, T. C. McBride
Buffalo, W. H. Carrier	St. Louis, John Hunter
Chicago, Fay Woodmansee	St. Paul, Max Toltz
Cincinnati, J. T. Faig	San Francisco, Thos. Morrin
Cleveland, R. B. Sheridan	Seattle, R. M. Dyer
Michigan, H. W. Alden	Troy, A. E. Cluett

These sub-committees are composed of from 10 to 25 prominent engineers whose duty it is to canvass carefully the industrial establishments, technical schools and colleges in their vicinity seeking out eligible non-members, and to do all that they can in a proper, dignified manner to induce these engineers to make application for membership.

It is desired to extend the list of sub-committees as rapidly as possible to the end that every important engineering center in the country may be adequately covered.

Another activity of your Committee is the getting into touch with those members whose interest in the Society is waning to such an extent that they contemplate resigning. In many instances these people have renewed their interest and withdrawn their resignations. The Committee has also taken upon itself the work of following up those applicants who fail to qualify after election.

The Committee wishes to call the attention of all our members to the article which has been appearing each month on the first page of The Journal, and will in future appear on the inside front cover. In this space concise information regarding the Society is given which should interest all the members and keep them informed of the objects and privileges of the Society, so that they may be able to advise intelligently inquiring friends and associates as to the procedure necessary to secure membership in the Society.

The curves published herewith show the relative increase of membership for the four national engineering societies since each of them were organized. The vertical lines represent the division of years; the horizontal lines represent the membership in groups of 500 each. Up to 1900 the four societies were all pretty close together, but within the next few years the Electrical Engineers and the Civil Engineers became very active in adding to their membership. Up to 1912 when the Increase of Membership Committee was appointed The American Society of Mechanical Engineers had been making gradual increases in its membership, but it had the smallest number of any of the Societies. Our rate of growth from that time onward has been a little better than any other society.

A study of the geographical distribution of our membership shows that 77 per cent are located in ten states of the Union. There are two states that have but one member, three states that have but two members and five states that have but three members.

Twelve states have less than 90 members each and the remaining fourteen states and territories have less than 25 members each. It is interesting to note that England alone has 62 members; there are only 13 states in the Union that can boast of a greater membership. This indicates that either a large part of our American engineers fail to appreciate the advantages of membership in our Society, or else the advantages of our Society have never been properly brought before them. Your Committee is making every effort to build up the Society by looking up all the engineers in this vast territory who are qualified for membership and the help of every loyal member is needed in the work.

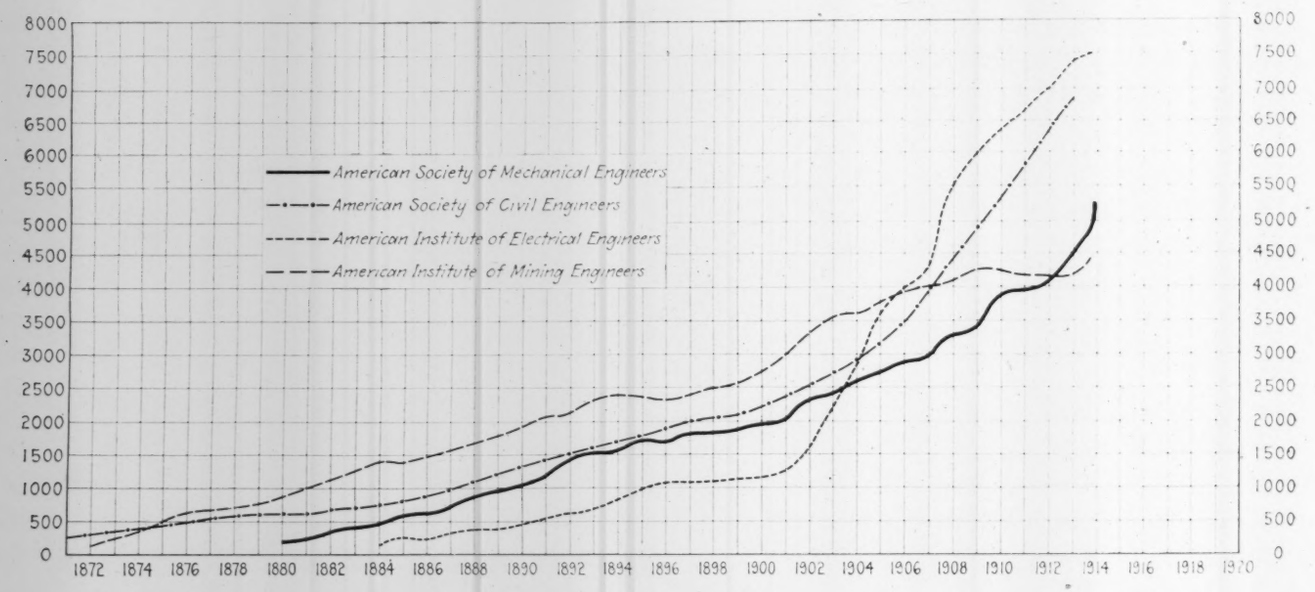
It should be borne in mind that this is a national society and it should make provision to take care of mechanical engineers wherever they may be. By increasing the membership the national society will be made stronger, the benefit to the individual member will be greater and there will be no reason for the existence of the multitude of small and comparatively weak societies which are now springing up all over the country.

Another fact which the Committee believes should have the serious consideration of the Society is that under B-2:

> Applications for membership from Engineers *who are not resident in United States or Canada,* and who may be so situated as not to be personally known to five members of the Society, may be recommended for ballot by five members of the Council, after sufficient evidence has been secured to show that in their opinion the applicant is worthy of admission to the grade which he seeks.

An engineer living in South Dakota where the Society has but one member in the entire state, or from Wyoming where there are but two members in the state, is required to refer to five members of the Society, who not only know him, but have *personal knowledge* of his work. Does it seem at all fair that we accept the application of a Hindoo living in India upon the recommendation of engineers of which the Society has no intimate knowledge? In cases of this kind it is customary to make an investigation through the members of other recognized engineering societies, such as, the British Institution of Mechanical Engineers. The Committee does not criticize the methods employed in dealing with cases which come under B-2, but it believes that we should extend the same or similar privileges to citizens of our own country who reside in states where we have a limited membership.

The Committee has endeavored to build up the Society not only in the industrial centers, but throughout the country wherever engineers are to be found. However, in no case has an invitation to join the Society been extended by the Committee to anyone not suggested by a member. Therefore, the success of the work and the standing of the engineers invited has been dependent upon the response made by the membership. Not more than one-tenth of the members have thus far responded to the efforts of the Committee in this important work, and while much has been accomplished a great deal remains to be done, and it is earnestly hoped that the results already obtained will induce every member to shoulder his share of a work in which all can and should participate.



Respectfully submitted,

Committee on Increase of Membership

I. E. Moultrop, *Chairman*
H. V. O. Coes
F. H. Colvin
J. V. V. Colwell
R. M. Dixon
W. R. Dunn
J. P. Ilsley
E. B. Katte
R. B. Sheridan
H. Struckman

PERSONAL NOTES

Prof. Winslow H. Herschel, formerly assistant professor of mechanical engineering at the University of Maine, has been appointed assistant physicist of the Bureau of Standards in Washington.

Dr. John A. Mathews, manager of the Halcomb Steel Company of Syracuse, N. Y., has been appointed one of a committee of three on the electrometallurgy of iron and steel of the American Electrochemical Society.

Geo. H. Cunningham has resigned as Professor of Mechanical Engineering at the University of Montana, Missoula, Mont., to accept a position in the engineering department of the Anaconda Copper Mining Company, Anaconda, Mont.

The new firm of Norton and Bird, of Chicago, consisting of William J. Norton and Paul P. Bird, has opened its consulting office in the Commercial Bank Building and is prepared to undertake services along the line of rate surveys and schedules, public service properties, etc. Both members of the firm were formerly connected with the Commonwealth Edison Company.

R. G. Williams, formerly assistant research engineer of the Norton Company of Worcester, Mass., has been placed at the head of the company's new department of Safety Engineering. Particular attention is to be given to safety in connection with grinding wheels and the department will keep in touch with the departments of labor, the national council for industrial safety, and the safety engineers of other large corporations. It is expected to draw up specifications for safety devices to be used in connection with grinding wheels.

Dr. Hollis Godfrey has been appointed to the presidency of Drexel Institute of Art, Science and Industry, Philadelphia. Dr. Godfrey has made a study of management methods as applicable to education and is experienced also in the problems of the manufacturer, the merchant and the engineer. Previous to accepting this position he made a study of the needs and opportunities of the institute, through the coöperation of the city administration of Philadelphia, in the furtherance of its plans for the education of city employees. His final report, based upon this survey, has been accepted by the trustees of the institute and his conclusions and recommendations heartily approved.

The committee recently appointed by the Board of Water Commissioners of the City of Hartford to secure the services of experts to pass upon the design and construction of several large dams to be erected in the near future has been able to retain John R. Freeman, Past-President of the Society, to coöperate with Thomas P. Stearns of Boston, and Caleb Mills Saville, chief engineer of the City of Hartford. Mr. Freeman's hydraulic work is known throughout the country, and he has been connected with city supply problems in New York, Boston, Nashua, N. H., Los Angeles, and Baltimore, and with the Isthmian canal lock dams and the water power conservation work of the Canadian Government.

Heinrich J. Freyn, formerly consulting engineer of the gas engineering department of the Allis-Chalmers Manufacturing Company of Milwaukee, Wis., has accepted the position of third vice-president of the H. Koppers Company, of Chicago, builders of by-product coke ovens, gas plants, benzol recovery plants, and by-product recovery gas producer plants, and consulting engineers in matters concerning fuel economy in blast furnaces and steel plants. Mr. Freyn's large experience along these lines and especially in gas engine matters will thus be at the disposition of these industries. He will devote considerable attention to installations of coke oven gas power plants in connection with Koppers cross regenerative by-product coke ovens.

The floating drydock, designed by Wm. T. Donnelly of New York and recently put into commission by the Inter-Island Steam Navigation Company of Honolulu, is capable of docking ships up to and including 4500 tons. It is of the pontoon type, with a length over pontoons of 302 feet, with a width of 76 feet between wings. It has been designed so that the length may be increased to 400 feet, giving it a lifting capacity of 7000 tons. At its present capacity it is composed of nine pontoons 32 feet wide, 100 feet long and 10 feet deep, constructed of wood, and has continuous steel wings 30 feet high by 302 feet long. The pontoons are divided into two water-tight compartments by a center bulkhead, and each compartment is provided with a flood gate valve and a centrifugal pump for sinking and raising the dock.

STEVENS INSTITUTE OF TECHNOLOGY MEETING

Dr. Alex. C. Humphreys, President of Stevens Institute of Technology and Past-President of the Society, John W. Lieb, Jr., manager of the New York Edison Company, and James E. Sague, a member of the New York Public Service Commission, both members of the Society, and other prominent engineers will speak at the Technology Meeting, on January 9, at 3 o'clock in the Stevens Institute of Technology. The topic of the meeting will be Public Service Corporations and their Relations to the Public, and the members of the Society are invited to attend.

DEPARTMENT OF ENGINEERING AT THE JOHNS HOPKINS UNIVERSITY

The Johns Hopkins University has established a department of engineering for which extensive laboratories and class room buildings are now under construction, made possible by large appropriations from the State of Maryland, which, however, exercises no control over the university. The new buildings have complete facilities for graduate and research work as well as for the undergraduate courses. Courses in Civil, Electrical and Mechanical Engineering have been established. Professor Carl C. Thomas, formerly head of the department of mechanical engineering at the University of Wisconsin, is the director of the new course in mechanical engineering. The department of engineering will not include machine shops, except as used for machine tools in laboratory equipment. Each undergraduate student will be required to spend four months in a commercial shop or drawing office during his course in addition to some field work in surveying during the summer vacation. The Johns Hopkins University has long been known for its research work and much of the effort of the engineering department will be concentrated upon engineering research. Fifty-five undergraduates and fifteen graduate students have entered the department this fall.

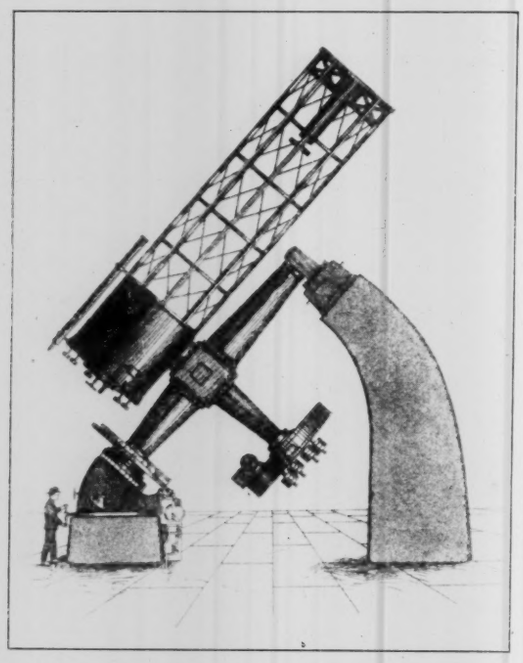
THE LARGEST REFLECTING TELESCOPE

The 60-inch reflecting telescope at the Mount Wilson Observatory, Cal., is at the present time the largest in existence, and its revelations have greatly advanced the knowledge of the stellar universe. There is now to be constructed

for the Dominion Observatory at Ottawa, Canada, a 72-inch reflector, which will be 50 per cent more powerful than this. The work of construction will be directed by three of the members of the Society who have done so much for the practical advancement of the science of astronomy, Worcester R. Warner and Ambrose Swasey, Past-Presidents, and John A. Brashear, Honorary Member. The contract for the mounting has been awarded to the Warner & Swasey Company of Cleveland, which also built the mountings for the Lick telescope in 1887, with its 36-inch object glass, and the Yerkes telescope in 1893, 40 inches in diameter. The optical parts will be constructed by the J. A. Brashear Company, Ltd., of Pittsburgh.

Mr. Warner has supplied the following information:

The Canadian instrument will, when completed, weigh fully 50 tons and will rest upon massive piers of concrete. The tube which will be 30 feet long and 7 feet in diameter,



will weigh 10 tons. At the lower end of the tube will be located the principal speculum composed of a disk of glass 73 inches in diameter, 10 inches in thickness, and weighing approximately 2 tons. When used as a Cassegrainian instrument a secondary convex reflector, 19 inches in diameter, will be placed near the end of the tube for reflecting rays back through a hole in the speculum, 10 inches in diameter, to the great spectroscope attached to the lower end of the tube. As a Newtonian instrument, a flat mirror will be provided for reflecting the cone of rays at right angles into the photographic apparatus at the upper edge of the tube. As a direct vision instrument, both secondary mirrors will be removed and appliances for visual, photographic and spectroscopic work will be attached at the prime focus. The tube and the declination and polar axes, with their attachments, weigh 35 tons, and so nicely is each part balanced and adjusted that the powerful driving clock will revolve this immense weight with such accuracy and uniformity that the spider line in the eyepiece of the pointing telescope, attached to the great tube, can be kept exactly on the center of the star in observation.

For visual and micrometric instruments the great refracting telescopes, such as the Lick and Yerkes, will maintain their supremacy, while for astronomical photography the great reflecting telescopes are far superior. A number of reflecting telescopes of large sizes are in contemplation in various parts of the world at the present time, and it is very probable that at an early date news will be received of projects to build other large instruments of this kind.

COLLEGE REUNIONS

A number of colleges held their alumni reunions on the evening of Friday, December 5, in conjunction with the Annual Meeting. A brief account of the various events is given herewith:

STEVENS INSTITUTE OF TECHNOLOGY

The Alumni Association of Stevens Institute of Technology gave a theater party at the New Amsterdam Theater on their Annual Stevens Night. The house was decorated with the college colors and was filled with alumni and undergraduates and their friends. Calvin W. Rice, Dr. W. F. M. Goss, Dr. Alex. C. Humphreys, and James Hartness were guests of the association. A supper and dance at the Hotel Astor followed the performance.

WORCESTER POLYTECHNIC INSTITUTE

The alumni of Worcester Polytechnic Institute gave a dinner in the College Room of the Hotel Astor in honor of the institute's new president, Ira N. Hollis, formerly professor of mechanical engineering at Harvard. About sixty-five alumni were present and a most enthusiastic meeting followed the dinner. The speakers of the evening were Professor Hollis and Mr. Charles G. Washburn, president of the board of trustees.

POLYTECHNIC INSTITUTE OF BROOKLYN

The annual reunion of the alumni of the Polytechnic Institute of Brooklyn was held in the rooms of the Society. Short addresses were made by Dr. Goss and Mr. F. W. Atkinson, president of the Institute, after which a reception was held.

YALE UNIVERSITY

Twenty-nine alumni attended the Engineering Alumni Dinner of Yale University given at the Yale Club. Prof. L. P. Breckenridge presided, and the affair was so successful that a committee was appointed to consider the formation of a Yale Engineering Society, with an annual reunion of this same character as one of the prominent features.

KENTUCKY STATE UNIVERSITY

The Kentucky State University Club of New York held an informal dinner and meeting at Keene's Chop House. After dinner the affairs of the university were brought up for discussion and the work of the New York Club now under way was fully outlined.

BROWN UNIVERSITY

The engineering alumni of Brown University held their reunion dinner at the Brown Club.

CORNELL UNIVERSITY

The Cornell University reunion dinner was held at the Cornell University Club with an attendance of fifty-four. Addresses were made by members of the club.

REPORT OF THE COMMITTEE OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS ON STANDARDIZATION OF FLANGES[1]

THE Committee on Standardization of Flanges of The American Society of Mechanical Engineers, has presented the following report on a standard for pipe flanges, fittings, and bolting for the same, together with a recommendation in regard to minimum thickness of wall in cast-iron pipe. The committee recommends that this new standard shall be known as the American Standard.

This new standard was arrived at after a long series of conferences with the Committee of Manufacturers on Standardization of Fittings and Valves and is a compromise, consistent with good engineering practice, between the 1912 U. S. Standard heretofore recommended by the Society's committee (published in The Journal for February 1912) and the Manufacturers' Standard adopted in 1912.

In addition to the adoption of the compromise standard, the committee, in conjunction with the Manufacturers' Committee, have extended the standard weight or low-pressure sizes from 30 in. to 100 in., in order to provide for the large sizes now called for in connection with steam-turbine installations, etc., and have also extended the extra heavy or high-pressure sizes from 24 in. to 48 in., in order to take care of high-pressure water mains.

The committee believes that the compromise standard here presented combines all the advantages of the 1912 U. S. Standard with the best points in the Manufacturers' Standard, and, owing to the extension from 30 in. to 100 in. in the low-pressure and from 24 in. to 48 in. in the high-pressure sizes, gives much more consistent dimensions and stresses in the larger sizes.

FLANGES AND BOLTS

General. Generally speaking, in so far as flanges and bolting are concerned, the 1912 U. S. Standard 125-lb. schedule, sizes 1 in. to 30 in. inclusive, remains almost unchanged. Nearly all of the alterations to the flanges and the bolting of the 250-lb. 1912 U. S. Standard, 1 in. to 24 in. inclusive, are the result of compromises with the Manufacturers' Standard, and when taken in connection with new additional sizes, 26 in. to 48 in. inclusive, form a more regular design than would have occurred had the manufacturers' sizes been accepted without compromise.

Fig. 1 contains comparative bolt stress curves of 125-lb. sizes, 1 in. to 30 in., and 250-lb., 1 in. to 24 in., for the Manufacturers' Standard of October 1912, the 1912 U. S. Standard, and the proposed American Standard. It will be plainly seen from the more regular form of curve that the new American Standard is better than either of the other two. The bolt stress curve at the 4-in., 22-in. and 24-in. sizes of the 125-lb. standard have been made less abrupt. The one for the 250-lb. standard at the 14-in., 16-in., 18-in., 20-in., 22-in. and 24-in. sizes shows the compromise more in favor of the 1912 U. S. Standard than that of the Manufacturers', and at the same time, as before stated, connecting better with the curve for new additional sizes.

Bolt Circles. The only 1912 U. S. bolt circle changed was on the 250-lb. 10-in. size. This was changed from $15\frac{3}{4}$ in. to $15\frac{1}{4}$ in. in diameter, as a result of a conference with the Manufacturers' Committee. The Manufacturers' Committee adopted the 1912 U. S. Standard bolt circles for the 250-lb. 14-in., 15-in., 18-in., 20-in., 22-in. and 24-in. pipe sizes, changing in each case their October 1912 Standard to do so.

Flange Diameters. Regarding flange diameters, the 250-lb. 9-in. and 10-in. sizes were changed to suit the Manufacturers' schedule. Sizes 12-in., 14-in., 15-in., 16-in., 18-in. and 20-in. were also changed and form a fair compromise between the 1912 U. S. and the Manufacturers' Standards. The American Standard flange diameters for the 22-in. and 24-in. pipe sizes are identical with those of the 1912 U. S. Standard, the Manufacturers' Committee changing their own standard to adopt same. Nearly all of these changes were made to suit the changed diameters of bolts before mentioned.

Flange Cross Sections. Every effort has been made to grade all sizes as uniformly as was found consistent with sudden changes in the number of bolts necessary to allow of flanges turning on 90-deg. angles.

Bolt Diameters, 125-Lb. Working Pressure. Changes which were made to the 1912 U. S. 125-lb. Standard are as follows: the $\frac{3}{4}$ in. diameter of bolt for the 4-in. size was made $\frac{5}{8}$ in., making it conform to the Manufacturers' Standard. The bolts on the 22-in. and 24-in. sizes were increased from $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in. diameter (American Standard). These changes were made to improve the conformity of the stress curve.

250-Lb. Working Pressure. The changes made to the 1912 U. S. 250-lb. Standard are shown on Fig. 1, as follows: The $1\frac{1}{4}$ in. diameter of bolt for the

[1] Here published in abstract, with an abstract of the discussion upon the report given at the Annual Meeting, 1913. There will be opportunity for further discussion upon it at the next Spring Meeting. Complete copies of the report may be purchased of the Society. Price to members, 20 cents per copy; to non-members, 40 cents per copy.

14-in. size is now 1⅛ in. The 1⅜ in. for the 16-in. and 18-in. sizes is changed to 1¼ in. The 1½ in. diameter for the 20-in. size is made 1⅜ in. In meeting the requirements of the American Standard, the Manufacturers' Committee changed their bolt diameters for the 12-in., 14-in., 15-in., 16-in., 18-in., 20-in., 22-in. and 24-in. pipe sizes.

Changes in Number of Bolts. The number of bolts on the 22-in. and 24-in. sizes was changed from 28, in the 1912 U. S. and the Manufacturers' Standards, to 24, to agree with the American Standard.

FLANGED FITTINGS

1 In. to 30 In. in Diameter for 125 Lb. and 1 In. to 24 In. for 250 Lb. Working Pressure per Sq. In.

The new schedule for flanged fittings is made up of dimensions, many of which are common to both the 1912 U. S. Standard and the Manufacturers' Standard of October 1, 1912. The remaining dimensions were suggested by the Manufacturers' Committee as changes to their own standard of October 1912, in an attempt to approach the 1912 U. S. Standard as closely as possible, and at the same time to admit of making use of many of their present patterns. As the suggestions of the Manufacturers did not involve any question of strength, and as the variations from the 1912 U. S. Standard were, for the most part, slight (as shown by comparative curves of face to face dimensions, Figs. 2 and 3), it was considered advisable to adopt these suggestions.

Additional Sizes. Additional sizes of 125-lb. flanged fittings, 32 in. to 100 in. inclusive, and 250-lb., 26 in. to 48 in. inclusive, were worked up in schedule form by the Manufacturers' Committee and presented for the consideration of the A.S.M.E. Committee. The A.S.M.E. additional flange and bolting sizes were all incorporated in the designs for these fittings. Curves of center to face dimensions were then worked up in connection with the present standard sizes and were found by the A.S.M.E. Committee to form a complete and uniform design.

Interchangeability. On all reducing tees and crosses from 1 in. to 9 in. inclusive, the center to face dimension of the various outlets is the same on fittings of the same size run.

Example: All center to face dimensions of a 5-in. by 5-in. by 1-in. tee are the same as a 5-in. by 5-in. by 5-in. tee and are interchangeable with any combination of 5-in. cross.

Cast-Iron Pipe Wall Thicknesses. In connection with the flange and fitting schedules, it was considered desirable to determine a minimum for pipe wall thicknesses, for 125-lb. sizes, 1 in. to 100 in., and 250 lb. 1 in. to 48 in. Accordingly, curves were plotted from a formula adopted July 18, 1894, by the Committees of the A.S.M.E. and the Master Steam and Hot Water Fitters Association for 75-lb. and 200-lb. flange schedule. The thicknesses derived from this formula were found to be somewhat thinner than those in use by the manufacturers. The formula was then increased by a constant of 1.2 and curves plotted, which was embodied in the new standard and values for which are given in Tables 1 and 2. The 125-lb. curve of the Manufacturers' sizes coincides with that of the American Standard for all standard sizes, except the 30-in., which, together with additional sizes 32 in. to 48 in., call for a gradual increase in thicknesses. The 250-lb. curve of the Manufacturers closely follows that of the American Standard.

Pipe Wall Stresses. The stresses in pipe walls given in the new American Standard schedules, Tables 1 and 2 (125-lb. and 250-lb.), are calculated by the following formula in customary use for low pressures:

$$S = \frac{D \times p}{2 \times t}$$

where

D = inside diameter of pipe t = thickness of pipe p = working pressure per sq. in.,

or more simply

$$S = \frac{r \times p}{t}$$

where

r = inside radius of pipe

The highest stress was found to be 2000 lb. per sq. in. on the 250-lb. 46-in. and 48-in. pipe walls, giving a factor of safety of about 10.

EXPLANATORY NOTES

a Standard and Extra Heavy Reducing Elbows carry same dimensions center to face as regular Elbows of largest straight size.

b Standard and Extra Heavy Tees, Crosses and Laterals, reducing on run only, carry same dimensions face to face as largest straight size.

c If Flanged Fittings for lower working pressure than 125 lb. are made, they shall conform in all dimensions except thickness of shell, to this standard and shall have the guaranteed working pressure cast on each fitting. Flanges for these fittings must be standard dimensions.

d Where long radius fittings are specified, it has reference only to Elbows which are made in two center to face dimensions and to be known as Elbows and Long Radius Elbows, the latter being used only when so specified.

e All standard weight fittings must be guaranteed for 125-lb. working pressure and extra heavy fittings for 250-lb. working pressure, and each fitting must have some mark cast on it indicating the maker and guaranteed working steam pressure.

f All extra heavy fittings and flanges to have a raised surface of 1/16 in. high inside of bolt holes for gaskets.

Standard weight fittings and flanges to be plain faced.

Bolt holes to be ⅛ in. larger in diameter than bolts.

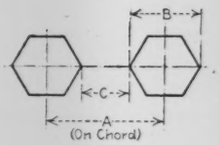
Bolt holes to straddle center line.

g Size of all fittings scheduled indicates inside diameter of ports, except for extra heavy fittings 14 in. and larger when the port diameter is ¾ in. smaller than nominal size.

h The face to face dimension of reducers, either straight

TABLE 1 SCHEDULE OF STANDARD PIPE FLANGES FROM 1 IN. TO 100 IN. FOR 125-LB. WORKING PRESSURE

Diameter of Pipe	Thickness of Pipe $\left[\frac{P+100}{4\times S}D+0.333\left(1-\frac{D}{100}\right)\right]^{1.2}$ ($S=1800$)	Minimum Thickness (Fractions of an In.)	Stress on Pipe per Sq. In.	Diameter of Flange	Thickness of Flange	Width of Flange Face	Diameter of Bolt Circle	No. of Bolts	Diameter of Bolts	Effective Area	Stress per Sq. In. on Bolt Metal	Diameter of Bolt Holes	A	B	C
1	0.43	7/16	143	4	7/16	1 1/16	3	4	7/16	0.093	264	9/16	2.12	0.91	1.21
1 1/4	0.44	7/16	178	4 1/2	7/16	1 1/16	3 3/8	4	7/16	0.093	412	9/16	2.38	0.91	1.47
1 1/2	0.45	7/16	214	5	7/16	1 1/16	3 7/8	4	1/2	0.126	438	5/8	2.73	1.00	1.73
2	0.46	7/16	286	6	7/16	1 1/16	4 3/4	4	5/8	0.202	486	3/4	3.35	1.21	2.14
2 1/2	0.48	7/16	357	7	7/16	1 1/16	5 1/2	4	5/8	0.202	750	3/4	3.88	1.21	2.67
3	0.50	7/16	428	7 1/2	7/16	1 1/16	6	4	5/8	0.202	1093	3/4	4.23	1.21	3.02
3 1/2	0.52	7/16	500	8 1/2	7/16	1 1/16	7	4	5/8	0.202	1488	3/4	4.94	1.21	3.73
4	0.53	1/2	500	9	7/16	1 1/16	7 1/2	8	5/8	0.202	972	3/4	2.87	1.21	1.56
4 1/2	0.55	1/2	562	9 1/2	7/16	1 1/16	7 3/4	8	5/8	0.302	823	3/4	2.96	1.44	1.52
5	0.56	1/2	625	10	7/16	1 1/16	8 1/2	8	5/8	0.302	1016	3/4	3.25	1.44	1.81
6	0.60	9/16	667	11	1	1 1/16	9 1/2	8	5/8	0.302	1463	3/4	3.63	1.44	2.19
7	0.63	9/16	700	12 1/2	1 1/16	1 1/16	10 3/4	8	5/8	0.302	1991	3/4	4.11	1.44	2.67
8	0.66	5/8	800	13 1/2	1 1/8	1 1/16	11 1/4	8	5/8	0.302	2600	3/4	4.50	1.44	3.06
9	0.70	11/16	818	15	1 1/4	1 1/16	13 1/4	12	5/8	0.302	2194	3/4	3.43	1.44	1.99
10	0.73	3/4	833	16	1 3/16	1 1/16	14 1/4	12	5/8	0.420	1948	1	3.69	1.66	2.03
12	0.80	13/16	923	19	1 1/4	1 1/16	17	12	5/8	0.420	2805	1	4.40	1.66	2.74
14	0.86	7/8	1000	21	1 3/8	1 1/16	18 3/4	12	1	0.550	2915	1 1/8	4.86	1.88	2.98
15	0.90	7/8	1072	22 1/4	1 3/8	1 1/16	20	16	1	0.550	2510	1 1/8	3.90	1.88	2.02
16	0.93	1	1000	23 1/2	1 7/16	1 1/16	21 1/4	16	1	0.550	2856	1 1/8	4.14	1.88	2.26
18	1.00	1 1/16	1059	25	1 1/16	1 1/16	22 3/4	16	1 1/8	0.694	2865	1 1/4	4.44	2.09	2.35
20	1.07	1 1/8	1111	27 1/2	1 1/16	1 1/16	25	20	1 1/8	0.694	2829	1 1/4	3.91	2.09	1.82
22	1.13	1 3/16	1158	29 1/2	1 1/16	1 1/16	27 1/4	20	1 1/4	0.893	2660	1 3/8	4.26	2.31	1.95
24	1.20	1 1/4	1200	32	1 1/8	1 1/16	29 1/2	20	1 1/4	0.893	3166	1 3/8	4.62	2.31	2.31
26	1.27	1 5/16	1238	34 1/4	2	1 1/16	31 3/4	24	1 1/4	0.893	3096	1 3/8	4.14	2.31	1.83
28	1.33	1 3/8	1273	36 1/2	2 1/16	1 1/16	34	28	1 1/4	0.893	3078	1 3/8	3.81	2.31	1.50
30	1.40	1 7/16	1304	38 3/4	2 1/8	1 1/16	36	28	1 1/4	1.057	2985	1 3/8	4.03	2.53	1.50
32	1.47	1 1/2	1333	41 1/4	2 1/4	1 1/16	38 1/2	28	1 1/2	1.294	2775	1 5/8	4.31	2.75	1.56
34	1.54	1 9/16	1360	43 1/4	2 5/16	1 1/16	40 1/2	32	1 1/2	1.294	2741	1 5/8	3.97	2.75	1.22
36	1.60	1 5/8	1385	46	2 3/8	1 1/16	42 3/4	32	1 1/2	1.294	3073	1 5/8	4.19	2.75	1.44
38	1.67	1 11/16	1407	48 1/4	2 7/16	1 1/16	45 1/4	32	1 5/8	1.515	2924	1 3/4	4.43	2.96	1.47
40	1.73	1 3/4	1428	50 1/4	2 1/2	1 1/16	47 1/4	36	1 5/8	1.515	2880	1 3/4	4.11	2.96	1.15
42	1.82	1 13/16	1448	53	2 5/8	1 1/16	49 1/2	36	1 5/8	1.515	3175	1 3/4	4.31	2.96	1.35
44	1.87	1 7/8	1467	55 1/4	2 3/4	1 1/16	51 1/4	40	1 5/8	1.515	3136	1 3/4	4.06	2.96	1.10
46	1.94	1 15/16	1484	57 1/4	2 11/16	1 1/16	53 3/4	40	1 5/8	1.515	3428	1 3/4	4.22	2.96	1.26
48	2.00	2	1500	59 1/2	2 13/16	1 1/16	56	44	1 5/8	1.515	3393	1 3/4	3.98	2.96	1.02
50	2.07	2 1/16	1515	61 3/4	2 7/8	1 1/16	58 1/4	44	1 3/4	1.746	3195	1 7/8	4.14	3.19	0.95
52	2.14	2 1/8	1530	64	2 15/16	1 1/16	60 1/2	44	1 3/4	1.746	3456	1 7/8	4.30	3.19	1.11
54	2.20	2 3/16	1543	66 1/4	3	1 1/16	62 3/4	44	1 3/4	1.746	3726	1 7/8	4.45	3.19	1.26
56	2.27	2 1/4	1555	68 3/4	3	1 1/8	65	48	1 3/4	1.746	3674	1 7/8	4.26	3.19	1.07
58	2.34	2 5/16	1567	71	3 1/8	1 1/8	67 1/4	48	1 3/4	1.746	3941	1 7/8	4.40	3.19	1.21
60	2.41	2 3/8	1538	73	3 1/8	1 1/8	69 1/4	52	1 3/4	1.746	3892	1 7/8	4.19	3.19	1.00
62	2.47	2 7/16	1550	75 1/4	3 1/4	1 1/8	71 3/4	52	1 7/8	2.051	3538	2	4.34	3.41	0.93
64	2.54	2 1/2	1561	78	3 1/4	1 1/8	74	52	1 7/8	2.051	3770	2	4.48	3.41	1.07
66	2.61	2 9/16	1572	80	3 3/8	1 1/8	76	52	1 7/8	2.051	4010	2	4.60	3.41	1.19
68	2.68	2 11/16	1582	82 1/4	3 3/8	1 1/8	78 1/4	56	1 7/8	2.051	3952	2	4.38	3.41	0.97
70	2.74	2 3/4	1591	84 1/2	3 1/2	1 1/8	80 1/2	56	1 7/8	2.051	4188	2	4.51	3.41	1.10
72	2.81	2 13/16	1600	86 1/2	3 1/2	1 1/8	82 1/2	60	1 7/8	2.051	4136	2	4.33	3.41	0.92
74	2.88	2 7/8	1609	88 3/4	3 5/8	1 1/8	84 1/2	60	1 7/8	2.051	4368	2	4.44	3.41	1.03
76	2.94	2 15/16	1617	90 3/4	3 5/8	1 1/8	86 1/2	60	1 7/8	2.051	4608	2	4.54	3.41	1.13
78	3.01	3	1625	93	3 3/4	1 1/8	88 3/4	60	2	2.302	4325	2 1/8	4.66	3.63	1.03
80	3.08	3 1/16	1633	95 1/4	3 3/4	1 1/8	91	60	2	2.302	4549	2 1/8	4.78	3.63	1.15
82	3.15	3 1/8	1640	97 1/2	3 7/8	1 1/8	93 1/4	60	2	2.302	4779	2 1/8	4.90	3.63	1.27
84	3.21	3 3/16	1647	99 3/4	3 7/8	1 1/8	95 1/2	64	2	2.302	4702	2 1/8	4.68	3.63	1.05
86	3.28	3 1/4	1653	102	4	1 1/8	97 3/4	64	2	2.302	4928	2 1/8	4.79	3.63	1.16
88	3.35	3 5/16	1660	104 1/4	4	1 1/4	100	68	2	2.302	4857	2 1/8	4.60	3.63	0.97
90	3.41	3 3/8	1667	106 1/2	4 1/8	1 1/4	102 1/4	68	2 1/8	2.648	4416	2 1/4	4.71	3.83	0.88
92	3.48	3 1/2	1643	108 3/4	4 1/8	1 1/4	104 1/2	68	2 1/8	2.648	4615	2 1/4	4.81	3.83	0.98
94	3.55	3 9/16	1649	111	4 1/4	1 1/4	106 1/4	68	2 1/8	2.648	4817	2 1/4	4.89	3.83	1.06
96	3.62	3 5/8	1655	113 1/4	4 1/4	1 1/4	108 1/2	68	2 1/4	3.023	4401	2 3/8	4.99	4.06	0.93
98	3.68	3 11/16	1661	115 1/4	4 3/8	1 1/4	110 3/4	68	2 1/4	3.023	4587	2 3/8	5.09	4.06	1.03
100	3.75	3 3/4	1667	117 3/4	4 3/8	1 1/4	113	68	2 1/4	3.023	4776	2 3/8	5.20	4.06	1.14



NOTES:—Bolt holes should straddle center lines. Flanges should be plain faced.

Square head bolts with hexagonal nuts are recommended. For bolts 1¾ in. diameter and larger stud with a nut at each end is satisfactory.

Hexagonal nuts for pipe sizes 1 in. to 46 in. can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 48 in. to 100 in. can be conveniently pulled up with box or socket wrenches.

RULES approximately followed in compiling above data:

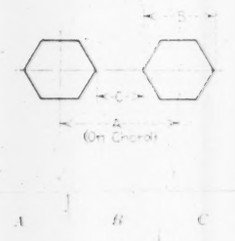
Bolt circle = $1.10\,D + 3$

Flange thickness = $0.0315\,D + 1.25$

D = inside diameter of pipe

TABLE 2 SCHEDULE OF EXTRA-HEAVY PIPE FLANGES FROM 1 IN. TO 48 IN. FOR 250-LB. WORKING PRESSURE

Diameter of Pipe	Thickness of Pipe $\left[\frac{P+100}{4\times S}D+0.33\left(1-\frac{D}{100}\right)\right]^{1.2}$ ($S=1800$)	Minimum Thickness (Fractions of an In.)	Stress on Pipe per Sq. In.	Diameter of Flange	Thickness of Flange	Width of Flange Face	Diameter of Bolt Circle	No. of Bolts	Diameter of Bolts	Effective Area	Stress per Sq. In. on Bolt Metal	Diameter of Bolt Holes	A	B	C
1	0.45	1/2	250	4 1/2	11/16	1 3/4	3 1/4	4	1/2	0.126	389	5/8	2.29	1.00	1.29
1 1/4	0.47	1/2	312	5	3/4	1 7/8	3 3/4	4	1/2	0.126	609	5/8	2.65	1.00	1.65
1 1/2	0.49	1/2	375	6	13/16	2 1/4	4 1/2	4	5/8	0.202	547	3/4	3.17	1.21	1.96
2	0.51	1/2	500	6 1/2	7/8	2 1/4	5	4	5/8	0.202	972	3/4	3.53	1.21	2.32
2 1/2	0.53	9/16	555	7 1/2	1	2 1/2	5 7/8	4	3/4	0.302	1016	7/8	4.15	1.44	2.71
3	0.56	9/16	667	8 1/4	1 1/8	2 5/8	6 5/8	8	3/4	0.302	731	7/8	2.53	1.44	1.09
3 1/2	0.59	9/16	778	9	1 3/16	2 3/4	7 1/4	8	3/4	0.302	995	7/8	2.77	1.44	1.33
4	0.61	5/8	800	10	1 1/4	3	7 7/8	8	3/4	0.302	1300	7/8	3.01	1.44	1.57
4 1/2	0.64	5/8	900	10 1/2	1 5/16	3	8 1/2	8	3/4	0.302	1646	7/8	3.25	1.44	1.81
5	0.67	11/16	909	11	1 3/8	3	9 1/4	8	3/4	0.302	2032	7/8	3.53	1.44	2.09
6	0.72	3/4	1000	12 1/2	1 7/16	3 1/4	10 5/8	12	3/4	0.302	1950	7/8	2.75	1.44	1.31
7	0.78	13/16	1077	14	1 1/2	3 1/2	11 7/8	12	7/8	0.420	1909	1	3.07	1.66	1.41
8	0.83	13/16	1230	15	1 5/8	3 1/2	13	12	7/8	0.420	2493	1	3.36	1.66	1.70
9	0.89	7/8	1285	16 1/4	1 3/4	3 5/8	14	12	1	0.550	2410	1 1/8	3.62	1.88	1.74
10	0.94	15/16	1333	17 1/2	1 7/8	3 3/4	15 1/4	16	1	0.550	2231	1 1/8	2.97	1.88	1.09
12	1.05	1	1500	20 1/2	2	4 1/4	17 3/4	16	1 1/8	0.694	2546	1 1/4	3.46	2.09	1.37
14	1.16	1 1/8	1555	23	2 1/8	4 1/2	20 1/4	20	1 1/8	0.694	2773	1 1/4	3.17	2.09	1.08
15	1.21	1 3/16	1579	24 1/2	2 3/16	4 3/4	21 1/2	20	1 1/4	0.893	2473	1 3/8	3.36	2.31	1.05
16	1.27	1 1/4	1600	25 1/2	2 1/4	4 3/4	22 1/2	20	1 1/4	0.893	2814	1 3/8	3.52	2.31	1.21
18	1.37	1 3/8	1636	28	2 3/8	5	24 1/4	24	1 1/4	0.893	2968	1 3/8	3.23	2.31	0.92
20	1.48	1 1/2	1666	30 1/2	2 1/2	5 1/4	27	24	1 3/8	1.057	3096	1 1/2	3.52	2.53	0.99
22	1.59	1 9/16	1760	33	2 5/8	5 1/4	29 1/4	24	1 1/2	1.295	3058	1 5/8	3.81	2.75	1.06
24	1.70	1 5/8	1846	36	2 3/4	5 3/4	32	24	1 5/8	1.515	3110	1 3/4	4.18	2.96	1.22
26	1.81	1 13/16	1793	38 1/4	2 13/16	6 1/8	34 1/2	28	1 5/8	1.515	3126	1 3/4	3.86	2.96	0.90
28	1.91	1 7/8	1866	40 3/4	2 15/16	6 3/8	37	28	1 5/8	1.515	3629	1 3/4	4.14	2.96	1.18
30	2.02	2	1875	43	3	6 1/2	39 1/4	28	1 3/4	1.746	3615	1 7/8	4.38	3.19	1.19
32	2.13	2 1/8	1882	45 1/4	3 1/8	6 5/8	41 1/2	28	1 7/8	2.051	3501	2	4.64	3.41	1.26
34	2.24	2 1/4	1889	47 1/2	3 1/4	6 3/4	43 1/2	28	1 7/8	2.051	3952	2	4.87	3.41	1.46
36	2.35	2 3/8	1894	50	3 3/8	7	46	32	1 7/8	2.051	3877	2	4.50	3.41	1.09
38	2.46	2 7/16	1948	52 1/4	3 7/16	7 1/8	48	32	1 7/8	2.051	4320	2	4.70	3.41	1.29
40	2.56	2 9/16	1953	54 1/2	3 9/16	7 1/4	50 1/4	36	1 7/8	2.051	4255	2	4.38	3.41	0.97
42	2.67	2 11/16	1953	57	3 11/16	7 1/2	52 3/4	36	1 7/8	2.051	4691	2	4.59	3.41	1.18
44	2.78	2 13/16	1955	59 1/4	3 3/4	7 5/8	55	36	2	2.302	4587	2 1/8	4.79	3.63	1.16
46	2.89	2 7/8	2000	61 1/2	3 7/8	7 3/4	57 1/4	40	2	2.302	4512	2 1/8	4.49	3.63	0.86
48	3.00	3	2000	65	4	8 1/2	60 3/4	40	2	2.302	4913	2 1/8	4.76	3.63	1.13



NOTES:—Bolt holes should straddle center lines. Flanges should have 1/16-in. raised face for gaskets.

Square head bolts with hexagonal nuts are recommended. For bolts 1⅝ in. diameter and larger stud with a nut at each end is satisfactory.

Hexagonal nuts for pipe sizes 1 in. to 16 in. can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 18 in. to 48 in. can be conveniently pulled up with box or socket wrenches.

RULES approximately followed in compiling above data:

Bolt circle $= 1.171\,D + 3.75$

Flange thickness $= 0.0546\,D \times 1.375$

D = inside diameter of pipe

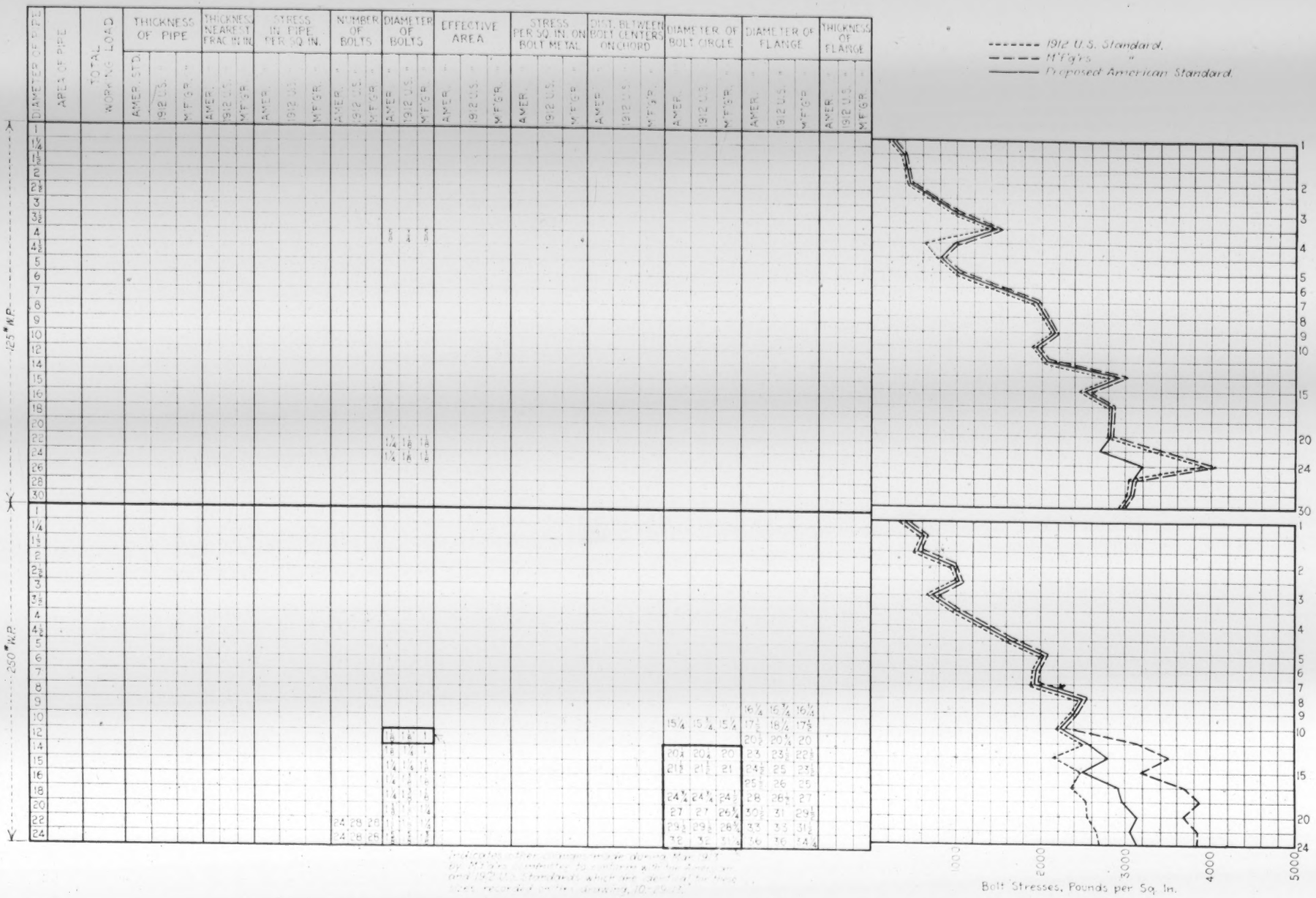


FIG. 1 COMPARISON OF AMERICAN STANDARD, 1912 U. S. STANDARD AND MANUFACTURERS' STANDARD, SHOWING WHERE DIFFERENCES OCCUR

TABLE 3 AMERICAN STANDARD, 125-LB. WORKING PRESSURE PER SQ. IN. STANDARD FLANGED FITTINGS, STRAIGHT SIZES

	Size	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20	22	24	26	28	30	32	34	36	38	40
A-A	Face to Face	7	7½	8	9	10	11	12	13	14	15	16	17	18	20	22	24	28	29	30	33	36	40	44	46	48	50	52	54	56	58	60
A	Center to Face	3½	3¾	4	4½	5	5½	6	6½	7	7½	8	8½	9	10	11	12	14	14½	15	16½	18	20	22	23	24	25	26	27	28	29	30
B	Center to Face of Long Radius Ells	5	5½	6	6½	7	7¾	8½	9	9½	10¼	11½	12¾	14	15¼	16½	19	21½	22¾	24	26½	29	31½	34	36½	39	41½	44	46½	49	51½	54
C	Center to Face of 45-Deg. Ells	1¾	2	2¼	2½	3	3	3½	4	4	4½	5	5½	5½	6	6½	7½	7½	8	8	8½	9½	10	11	13	14	15	16	17	18	19	20
D	Face to Face Laterals	7½	8	9	10½	12	13	14½	15	15½	17	18	20½	22	24	25½	30	33	34½	36½	39	43	46	49½	53	56	59	....	....	....	....	....	....
E	Center to Face	5¾	6¼	7	8	9½	10	11½	12	12½	13½	14½	16½	17½	19½	20½	24½	27	28½	30	32	35	37½	40½	44	46½	49	....	....	....	....	....	....
F	Center to Face	1¾	1¾	2	2½	2½	3	3	3	3	3½	3½	4	4½	4½	5	5½	6	6	6½	7	8	8½	9	9	9½	10	....	....	....	....	....	....
G	Face to Face Reducer	....	....	....	....	....	6	6½	7	7½	8	9	10	11	11½	12	14	16	17	18	19	20	22	24	26	28	30	32	34	36	38	40
	Diameter of Flange	4	4½	5	6	7	7½	8½	9	9¼	10	11	12½	13½	15	16	19	21	22¼	23½	25	27½	29½	32	34¼	36½	38¾	41¾	43¾	46	48¾	50¾
	Thickness of Flange	7/16	1/2	9/16	5/8	11/16	3/4	13/16	15/16	15/16	15/16	1	1 1/16	1⅛	1¼	1 3/16	1¼	1⅜	1⅜	1⅜	1 7/16	1 9/16	1 11/16	1 13/16	1⅞	2	2 1/16	2⅛	2¼	2 5/16	2⅜	2⅜	2½
	Diameter of Bolt Circle	3	3⅜	3⅞	4¾	5½	6	7	7½	7¾	8½	9½	10¾	11¾	13¼	14¼	17	18¾	20	21¼	22¾	25	27¼	29½	31¾	34	36	38½	40½	42¾	45¼	47¼
	No. of Bolts	4	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	12	16	16	16	20	20	20	24	28	28	28	32	32	32	36
	Diameter of Bolts	7/16	7/16	1/2	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	7/8	7/8	1	1	1	1¼	1⅛	1¼	1¼	1¼	1¼	1⅜	1½	1½	1½	1⅝	1⅝
	Minimum Metal Thickness of Body	7/16	7/16	7/16	7/16	7/16	7/16	7/16	1/2	1/2	9/16	5/8	5/8	11/16	3/4	13/16	7/8	7/8	1	1 1/16	1⅛	1 3/16	1¼	1 5/16	1⅜	1 7/16	1½	1 9/16	1⅝	1 11/16	1¾	

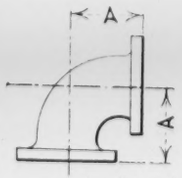
	Size	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
A-A	Face to Face	62	64	66	68	70	74	78	82	84	88	90	94	96	100	102	106	108	112	116	118	120	124	126	130	134	136	138	142	146	148
A	Center to Face	31	32	33	34	35	37	39	41	42	44	45	47	48	50	51	53	54	56	58	59	60	62	63	65	67	68	69	71	73	74
B	Center to Face of Long Radius Ells	56½	59	61½	64	66½	69	71½	74	76½	79	81½	84	86½	89	91½	94	96½	99	101½	104	106½	109	111½	114	116½	119	121½	124	126½	129
C	Center to Face of 45-Deg. Ells	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
D	Face to Face Laterals	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
E	Center to Face	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
F	Center to Face	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
G	Face to Face Reducer	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
	Diameter of Flange	53	55¼	57¼	59½	61¾	64	66¼	68¾	71	73	75¾	78	80	82¼	84½	86½	88½	90¾	93	95¼	97½	99¾	102	104¼	106½	108¾	111	113¼	115½	117¾
	Thickness of Flange	2⅝	2⅝	2 11/16	2¾	2¾	2⅞	3	3	3⅛	3⅛	3¼	3¼	3⅜	3⅜	3½	3½	3⅝	3⅝	3¾	3¾	3⅞	3⅞	4	4	4⅛	4⅛	4¼	4¼	4⅜	4⅜
	Diameter of Bolt Circle	49½	51¾	53¾	56	58¼	60½	62¾	65	67¼	69¼	71¾	74	76	78¼	80½	82½	84½	86½	88¾	91	93¼	95½	97¾	100	102¼	104½	106¼	108½	110¾	113
	No. of Bolts	36	40	40	44	44	44	44	48	48	52	52	52	52	56	56	60	60	60	60	60	60	64	64	68	68	68	68	68	68	68
	Diameter of Bolts	1⅝	1⅝	1⅝	1⅝	1¾	1¾	1¾	1¾	1¾	1¾	1⅞	1⅞	1⅞	1⅞	1⅞	1⅞	1⅞	1⅞	2	2	2	2	2	2	2⅛	2⅛	2⅛	2¼	2¼	2¼
	Minimum Metal Thickness of Body	1 13/16	1⅞	1 15/16	2	2 1/16	2⅛	2 3/16	2¼	2 5/16	2 7/16	2½	2 9/16	2⅝	2 11/16	2¾	2 13/16	2⅞	2 15/16	3	3 1/16	3⅛	3 3/16	3¼	3 5/16	3⅜	3½	3 9/16	3⅝	3 11/16	3¾	

Notes:—Figures given are for center to face and for face to face finished dimensions. Where necessary manufacturers will make suitable allowances in patterns before casting.
Laterals do not extend beyond the 30-in. size at the present time. Box wrench to be used on bolting for large sizes.
Square head bolts with hexagonal nuts are recommended. 1⅝ in. diameter and larger stud with a nut at each end is satisfactory.
Hexagonal nuts for pipe sizes 1 in. to 46 in. can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 48 in. to 100 in. can be conveniently pulled up with socket wrenches.

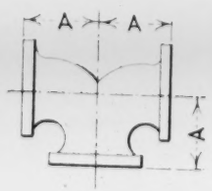
TABLE 4 AMERICAN STANDARD, 250-LB. WORKING PRESSURE PER SQ. IN., EXTRA HEAVY FLANGED FITTINGS, STRAIGHT SIZES

	Size	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
A-A	Face to Face	8	8½	9	10	11	12	13	14	15	16	17	18	20	21	23	26	30	31	33	36	39	41	45	48	52	55	58	61	65	68	71	74	78	81	84
A	Center to Face	4	4¼	4½	5	5½	6	6½	7	7½	8	8½	9	10	10½	11½	13	15	15½	16½	18	19½	20½	22½	24	26	27½	29	30½	32½	34	35½	37	39	40½	42
B	Center to Face of Long Radius Ells	5	5½	6	6½	7	7¾	8½	9	9½	10¼	11½	12¾	14	15¼	16½	19	21½	22¾	24	26½	29	31½	34	36½	39	41½	44	46½	49	51½	54	56½	59	61½	64
C	Center to Face of 45-Deg. Ells	2	2½	2¾	3	3½	3½	4	4½	4½	5	5½	6	6	6½	7	8	8½	9	9½	10	10½	11	12	13	14	15	16	17	18	19	20	21	22	23	24
D	Face to Face, Laterals	8½	9½	11	11½	13	14	15½	16½	18	18½	21½	23½	25½	27½	29½	33½	37½	39½	42	45½	49	53	57½	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
E	Center to Face, Laterals	6½	7¼	8½	9	10½	11	12½	13½	14½	15	17½	19	20½	22½	24	27½	31	33	34½	37½	40½	43½	47½	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
F	Center to Face, Laterals	2	2¼	2½	2½	2½	3	3	3	3½	3½	4	4½	5	5	5½	6	6½	6½	7½	8	8½	9½	10	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
G	Face to Face, Reducer	. .	. .	. .	. .	. .	6	6½	7	7½	8	9	10	11	11½	12	14	16	17	18	19	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
	Diameter of Flange	4½	5	6	6½	7½	8¼	9	10	10½	11	12½	14	15	16¼	17½	20½	23	24½	25½	28	30½	33	36	38¼	40¾	43	45¼	47½	50	52¼	54½	57	59¼	61½	65
	Thickness of Flange	11/16	3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 3/16	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 13/16	2 15/16	3	3 1/8	3 1/4	3 3/8	3 7/16	3 9/16	3 11/16	3 3/4	3 7/8	4
	Diameter of Bolt Circle	3¼	3¾	4½	5	5⅞	6⅝	7¼	7⅞	8½	9¼	10⅝	11⅞	13	14	15¼	17¾	20¼	21½	22½	24¾	27	29¼	32	34½	37	39¼	41½	43½	46	48	50¼	52¾	55	57¼	60¾
	No. of Bolts	4	4	4	4	4	8	8	8	8	8	12	12	12	12	16	16	20	20	20	24	24	24	24	28	28	28	28	28	32	32	36	36	36	40	40
	Diameter of Bolts	½	½	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	⅞	⅞	1	1	1⅛	1⅛	1¼	1¼	1¼	1½	1½	1⅝	1⅝	1⅝	1¾	1⅞	1⅞	1⅞	1⅞	1⅞	1⅞	2	2	2
	Minimum Metal Thickness of Body	½	½	½	½	9/16	9/16	9/16	⅝	⅝	11/16	¾	13/16	13/16	⅞	15/16	1	1⅛	1 3/16	1¼	1⅜	1½	1 9/16	1⅝	1 13/16	1⅞	2	2⅛	2¼	2⅜	2 7/16	2 9/16	2 11/16	2 13/16	2⅞	3

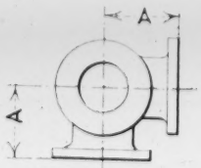
NOTES:—Figures given are for center to face and for face to face finished dimensions. Where necessary manufacturers will make suitable allowances in patterns before casting.
Laterals do not extend beyond the 24-in. size at the present time. Box wrench to be used on bolting for large sizes.
Square head bolts with hexagonal nuts are recommended. 1⅝ in. diameter and larger stud with a nut at each end is satisfactory.
Hexagonal nuts for pipe sizes 1 in. to 16 in. can be conveniently pulled up with wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 18 in. to 48 in. can be conveniently pulled up with socket wrenches.



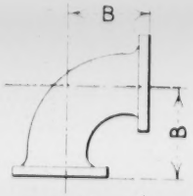
90° ELL



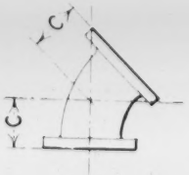
DOUBLE BRANCH ELL



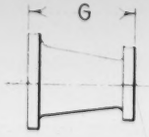
SIDE OUTLET ELL



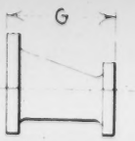
LONG RADIUS ELL



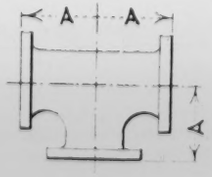
45° ELL



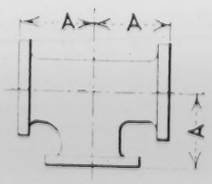
REDUCER



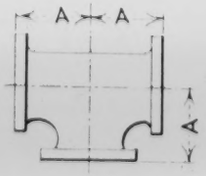
ECCENTRIC REDUCER



TEE



SINGLE SWEEP TEE



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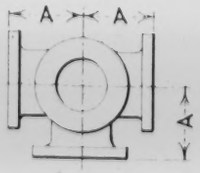
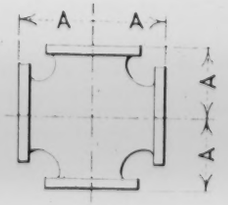
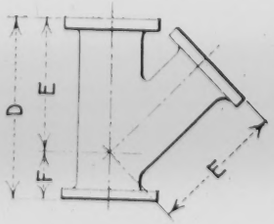


SIDE OUTLET TEE



CROSS



LATERAL

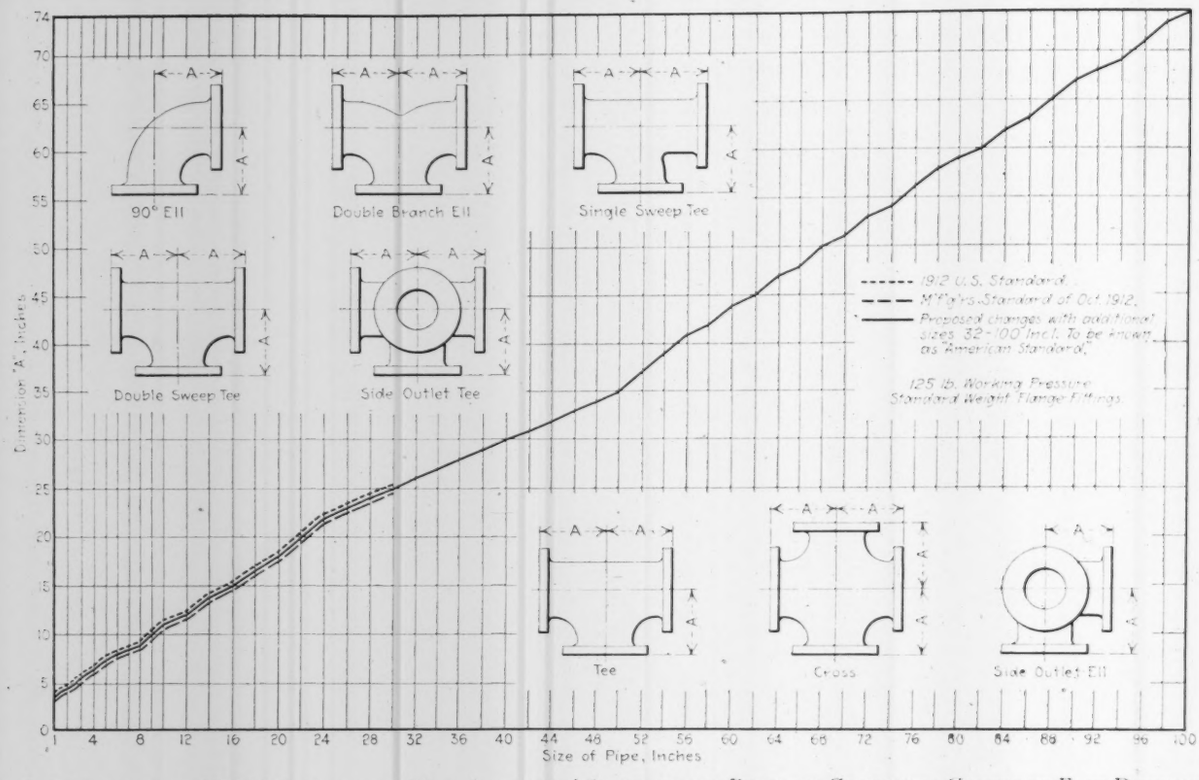


FIG. 2 COMPARISON OF 1912 U. S. STANDARD, MANUFACTURERS' STANDARD AND PROPOSED CHANGES IN CENTER TO FACE DIMENSIONS ELLS, TEES AND CROSSES FOR 125 LB. WORKING PRESSURE

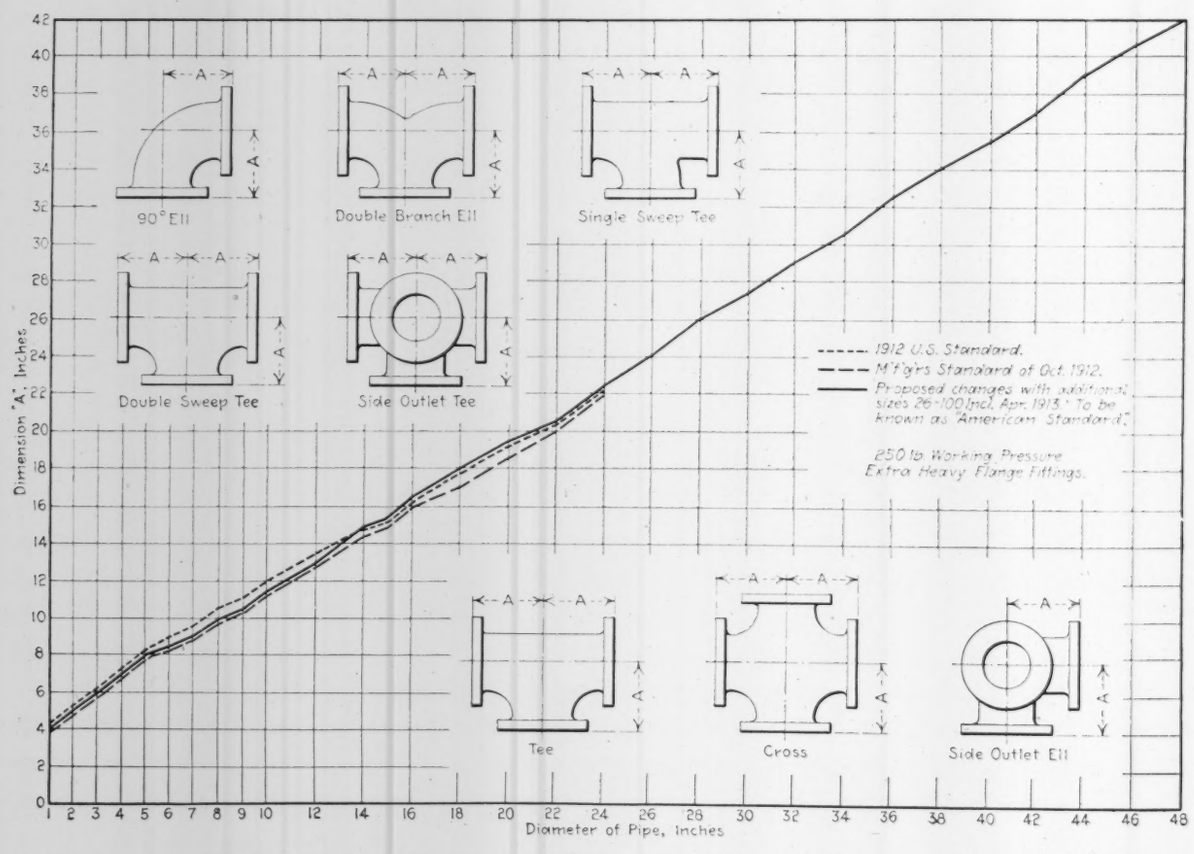


FIG 3 COMPARISON OF 1912 U. S. STANDARD, MANUFACTURERS' STANDARD AND PROPOSED CHANGES IN CENTER TO FACE DIMENSIONS ELLS, TEES AND CROSSES FOR 250 LB. WORKING PRESSURE

or eccentric, for all pressures, shall be the same face to face as given in table of dimensions.

i Square head bolts with hexagonal nuts are recommended.

For bolts, 1⅝ in. diameter and larger, studs with a nut on each end are satisfactory.

Hexagonal nuts for pipe sizes 1 in. to 46 in., on 125-lb. standard, and 1 in. to 16 in. on 250-lb. standard can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 48 in. to 100 in. on 125-lb. and 18 in. to 48 in. on 250-lb. standards, can be conveniently pulled up with box or socket wrenches.

j Twin Elbows, whether straight or reducing, carry same dimensions center to face and face to face as regular straight size ells and tees.

Side Outlet Elbows and Side Outlet Tees, whether straight or reducing sizes, carry same dimensions center to face and face to face as regular tees having same reductions.

k Bull Head Tees or Tees increasing on outlet, will have same center to face and face to face dimensions as a straight fitting of the size of the outlet.

l Tees and Crosses 9 in. and down, reducing on the outlet, use the same dimensions as straight sizes of the larger port.

Size 10 in. and up, reducing on the outlet are made in two lengths depending on the size of the outlet as given in the table of dimensions.

Laterals 3½ in. and down, reducing on the branch, use the same dimensions as straight sizes of the larger port.

m Sizes 4 in. and up, reducing on the branch, are made in two lengths depending on the size of the branch as given in the table of dimensions.

The dimensions of reducing flanged fittings are always regulated by the reductions of the outlet or branch. Fittings reducing on the run only, the long body pattern will always be used.

Y's are special and are made to suit conditions.

Double sweep tees are not made reducing on the run.

n Steel Flanges, Fittings and Valves are Recommended for Superheated Steam.

Respectfully submitted,

H. G. Stott, *Chmn.*
A. C. Ashton
A. R. Baylis
Wm. Schwanhausser
J. P. Sparrow
Members of Committee on Standardization of Flanges

W. M. McFarland, member of the Committee, heartily concurs in the above report except that he would like to see the principle of interchangeability carried out as far as practicable.

DISCUSSION

E. D. Denny[1] referred to the prominence and high professional ability of the members of the committees of the two societies which had been engaged on this problem. These men all worked diligently in the preparation of the 1912 U. S. Standard Schedule and many meetings were held for a comparison of views and a discussion of the various problems involved. When the final vote was taken on the finished schedule, it was adopted unanimously. In all this preparatory work there was no discussion of the differences between the proposed schedule and the existing schedules of the various manufacturers, no two of which were at that time alike. The only thought was to make a schedule that would provide the requisite, without excessive, strength, and that would make all side or lateral outlet fittings of the same size run interchangeable. The practical wisdom of the work of these committees is evidenced by the fact that their work has never been successfully attacked. A significant testimonial to the intrinsic merit of the schedule may be found in the action of the various departments of the U. S. Government. Up to July 1911 all Government specifications calling for flanged fittings described such fittings in detail; but as soon as the 1912 U. S. Schedule was issued and came to the attention of these Government experts it was adopted by one department after another—they saw that it had been prepared from the engineering standpoint and not from the commercial standpoint. Today practically every Government specification calling for flanged fittings provides that they must be in accord with the 1912 U. S. Standard.

There has been great opposition, both open and covert, to the universal adoption of this standard, but it has been based almost entirely on the expense that would attend the alteration of patterns. This was brought out at the hearing in Washington. The brief prepared by the Manufacturers' Association admitted the need of a uniform standard and tacitly admitted the intrinsic merits of the 1912 U. S. Standard Schedule, but it violently protested that it would be very expensive to alter existing patterns to conform to it. Then the Commissioner—the chairman of the meeting—quietly said: "You admit that there should be a uniform schedule, that the schedules of the various manufacturers are not now uniform—how would you ever get a uniform schedule without the expense of altering patterns?"

It would seem that there was but one wise plan for both these societies to pursue under such conditions. Several of the manufacturers have already altered their patterns, or made new patterns, and since July, 1912, it has been possible to get all sizes of flanged fittings in accordance with the 1912 U. S. Schedule and at as low prices as such fittings could be bought of other manufacturers whose schedules were different. It may be true that certain manufacturers have refused thus far to furnish such fittings at regular prices, but that would not be a sufficient reason for us to recede from a position that was deliberately taken after careful consideration.

It was the same some years ago when our societies in a similar manner issued the Schedule of Standard Flanges. Many of the manufacturers refused to accept it and for the same reason that they now refuse to accept the 1912 U. S. Standard Schedule—the expense of altering patterns. I think it was three years before the last most stubborn concern fell into line, but by our persistent insistence upon it the schedule was finally universally adopted and who can compute the benefit it has been to us for ten years past.

As the matter comes before the Society at this time it is in the form of a resolution, not simply to reopen the subject, but actually to cast aside the schedule which cost so much labor and expense to both societies, and which is very generally admitted to be practically perfect, but to adopt another schedule lacking the most important features of the one that was unanimously adopted and approved less than two years ago. There seems to be no argument for such a

[1] President, National Association of Master Steam and Hot Water Fitters.

course, except that unless we thus stultify ourselves, certain manufacturers will refuse to adopt our schedule, not because it is in anywise defective, but because they will not be at the expense of altering the patterns.

N. LORING DANFORTH read a history of the work of standardization that had been done by the National Association of Master Steam and Hot Water Fitters and The American Society of Mechanical Engineers. This had been prepared by himself, William T. English and Earnest T. Child, all members of both societies, and was printed for distribution at the meeting. The most essential points are given in the following abstract:

The standardization of flanges and flanged fittings was taken up by the National Association of Master Steam and Hot Water Fitters in 1905, at which time the manufacturers were invited to join them in preparing a standard; and in May, 1908, a request was received from The American Society of Mechanical Engineers to join in preparing a standard, which the Master Steam and Hot Water Fitters were very glad to have them do. While the manufacturers agreed that a standard was necessary, efforts to have them confer jointly with the two committees were unsuccessful.

The standard known as "The 1912 U. S. Standard" was adopted by the joint committee of the two societies in March, 1911; by the convention of the Master Steam and Hot Water Fitters in May, 1911, subject to slight changes; and in October, 1911, these final details were agreed upon by the joint committee.

In the fall of 1911 the 1912 U. S. Standard Schedule was recommended by the A.S.M.E. committee to the Council of the Society, presented to the Annual Meeting in December, and accepted and printed in the February, 1912, issue of The Journal.

The 1912 U. S. Standard has also been adopted by the Bureau of Standards of the United States Government, the Bureau of Yards and Docks of the United States Navy Department; and has been specified by the Department of the Interior, Department of Justice and Bureau of Supplies and Accounts, as well as by many consulting engineers, members of the A.S.M.E.

It was deemed advisable to confer with the American Water Works Association and the New England Water Works Association, as they are the principal users of fittings and flanges of the larger sizes. Through the efforts of the Master Steam and Hot Water Fitters a meeting was held in December, 1912, at which were present the chairmen of the committees of the four associations already mentioned. At this meeting the chairman of the A.S.M.E. committee presented a tentative schedule, regarding which it was agreed that the chairmen of the two waterworks associations' committees should check up the schedule and see if it would work in with the dimensions of the large size pipe used in waterworks construction.

About this time a prominent manufacturer began to realize that the 1912 U. S. Standard was becoming universally adopted and certain paragraphs appeared in various technical journals to the effect that manufacturers would not recognize that standard; that it was not definitely adopted and that it was to be revised or changed.

In the August, 1912, issue of The Journal of the A.S.M.E. appears the statement that "The Committee of The American Society of Mechanical Engineers have decided after the most careful consideration not to reopen the subject, as has been erroneously reported." This and other statements of similar purport have led the Master Steam and Hot Water Fitters to believe that the A.S.M.E. would not recede from its position.

In March, 1913, the chairman of the A.S.M.E. committee advised the Master Steam and Hot Water Fitters that he had held a number of conferences with the representative of a prominent manufacturer concerning a compromise schedule. It was a great surprise to learn this in view of his repeated statements that he would not entertain any change in the 1912 U. S. Standard. He then suggested to the chairman of the Master Steam and Hot Water Fitters' committee that a meeting of the two commitees be held (in May, 1913), and an effort in that direction was made, but owing to the nearness of the convention of the latter society and other engagements, it was found impossible to meet on the desired date and the chairman was so advised.

On June 4, 1913, the chairman of the A.S.M.E. committee advised the chairman of the Master Steam and Hot Water Fitters' committee that "The Committee on Standardization of Flanges of the A.S.M.E. had yesterday adopted by unanimous vote the new compromise standard known as the 1914 American Standard." The meeting referred to was held, absolutely ignoring the Association of Master Steam and Hot Water Fitters.

In view of the fact that the committees of the two associations had been working together so harmoniously for a period of more than two years, and that the 1912 U. S. Standard had not only been adopted by the joint committee, but confirmed by the National Association of Master Steam and Hot Water Fitters in convention assembled and by the Council of The American Society of Mechanical Engineers, we were astounded at the communication just quoted—especially, in view of the fact that the former association took the initiative and that the latter Society requested the opportunity to work with them on this question of preparing a standard for flanged fittings and flanges.

The printed statement further goes on to say that at one largely attended conference of the two committees the subject of the compromise schedule was fully discussed and that the representatives of the Master Steam and Hot Water Fitters were ready to adopt certain dimensions of flanges and fittings called for, provided, first, that the manufacturers would eliminate their short body fittings, thereby maintaining the interchangeable feature which was so important a feature in the 1912 U. S. Standard; second, that the name of this compromise should be the 1912 U. S. Standard, revised January 1st, 1914; and third that it should include the larger sizes of flanges after the dimensions of these larger flanges had been approved by the American Water Works Association and the New England Water Works Association.

It was felt that this was a very liberal concession and in view of this resolution, the chairmen of both committees were to confer with the chairman of the manufacturers' committee with a view to the ultimate adoption of this revised and enlarged schedule. No conference was arranged, but correspondence between the chairman of the A.S.M.E. committee and the chairman of the manufacturers' committee indicated that the concessions suggested were not agreeable to the latter. The committee of the Master Steam and Hot Water Fitters has therefore concluded that the 1912 U. S. Standard should be maintained. The members of this association and those who are affiliated with them and who have

adopted this standard are without question the largest consumers of these goods in the United States and the interchangeability feature of the 1912 U. S. Standard would mean a very large saving to them.

HENRY B. GOMBERS[1] said he had been asked by Mr. John H. Gregory, chairman of the Committee on Standardization of the American Water Works Association, to give as his opinion that it would be a great mistake to take any step looking toward a change of the 1912 U. S. Standard Schedule until after a conference had been held, in which every society interested in the matter was represented. He also confirmed what President Denny had said about the hearing in Washington. Mr. Stott had very ably sustained the position which he had taken with regard to the 1912 U. S. Standard with many excellent arguments. A month ago Mr. Gombers was in Washington and found that the views of the departments interested had not changed. They are still specifying material in accordance with the 1912 U. S. Standard and as evidence he exhibited a copy of the general schedule of supplies for the fiscal year 1914 dealing with electrical, engineering and plumbing supplies, in which the 1912 U. S. Standard is specified.

E. T. CHILD said there are many more changes in the report than would be inferred. The committee of the Master Steam and Hot Water Fitters' Association has counted up and listed these changes, and finds that there are over 250 of them. They have also compared the proposed schedule with various catalogue dimensions and find that it tallies more nearly with those of one manufacturer than with any other of the lot. Does the Society want to stultify itself to the extent of adopting the schedule of one manufacturer and putting all the others aside, especially when the 1912 U. S. Standard is conceded to be theoretically correct?

WILLIAM T. DONNELLY said that as a broad proposition, covering any committee report, he was opposed to throwing away one standard and adopting another. Having accepted any standard he thought it was not within the bounds of good practice to throw it away and adopt another; but that the one we already have should be revised.

CHARLES WHITING BAKER asked if the Committee on Standardization of Flanges had not been discharged when its previous report was submitted, or if the report had been referred back to the committee for further action and amendment; and also, if the new standard were adopted whether it would necessitate changes by some of the manufacturers who had already adopted the 1912 U. S. Standard. Mr. Stott replied: The standard was never taken out of the hands of the committee; the committee was not discharged and was at liberty to proceed with its work. The new standard has been adopted by the Manufacturers' Association which embodies 90 per cent of the output of flanges and fittings in the United States. There may be one or two who have adopted the 1912 U. S. Standard and some, he understood, who used the Independent Standard.

WALTER M. MCFARLAND, speaking as a member of the committee of The American Society of Mechanical Engineers, explained that while he sympathized with his friends of the Master Steam and Hot Water Fitters' Association about one or two of the points they were making, he wanted to add something to what had been said to show exactly what the conditions are. He emphasized the extreme difficulty that had been experienced in securing the cooperation of the manufacturers with respect to the 1912 U. S. Standard, saying in part:

After the two committees had agreed on the report containing this standard we met a committee of the Manufacturers' Association and were received very courteously at the beginning, but later on found they were not disposed to adopt the report or to have anything to do with it. We then arranged for another meeting of the committees representing The American Society of Mechanical Engineers and the Master Steam and Hot Water Fitters' Association, to which we urgently invited the manufacturers to send representatives, but so far as I can now remember they did not respond even to the invitation, and certainly did not send representatives.

A second effort was made to get the manufacturers to meet with the representatives of the two organizations referred to, but only one gentleman came, who distinctly said he came in his individual capacity, and in no sense as a representative of the Manufacturers' Association. In other words, the point I am trying to bring out is that up to the time of the adoption and promulgation of the 1912 U. S. Standard, the manufacturers had treated us with extreme discourtesy.

Thereafter, when the 1912 U. S. Standard was issued and was evidently going to be adopted by a great many people, some of the manufacturers shifted over. Then the manufacturers woke up and came to the conclusion that they had made a mistake and there was a disposition to get into line.

In my judgment, Mr. Stott was right when he was willing to meet these people and see if something could not be done to draw them all in. When we consider the subject carefully, we must understand that standards are not things to be worshipped, but ought to be things that, while substantially correct and as nearly perfect as possible, recommend themselves to the largest number of people interested.

Owing to an unfortunate misunderstanding, the joint meeting of the committees of The American Society of Mechanical Engineers and the Master Steam and Hot Water Fitters' Association, which was scheduled for some time in May of this year, did not come off, and, as I am given to understand, it was supposed for a time that the not respond even to the invitation, and certainly did not want to go on with any further discussion. However that may be, the discussion was continued with the manufacturers and a compromise was agreed upon.

Now here is where the manufacturers were wrong: As soon as the committee made its report, and before it could be brought up for discussion, the manufacturers published it and stated that it was to be the standard. Subsequently, the Committee of the Master Steam and Hot Water Fitters' Association, as they say in the printed statement read by Mr. Danforth, came to the point where, if they could have the principle of interchangeability carried out and could retain the name as the 1912 U. S. Standard *Revised*, they were willing to concede a number of other things. We asked Mr. Stott to take up these features with the manufacturers, as it seemed to most of us that the request was not an unreasonable one. The manufacturers replied, however, that they had already published a lot of literature and did not see how they could

[1] Secretary, National Association of Master Steam and Hot Water Fitters.

make any change. That, however, is no logical reason at all for declining to do so when we consider all the matter which this Society and the Master Steam and Hot Water Fitters' Association has put out about the other standard. As I understand it, this is the condition of affairs to-day.

A. R. Baylis (contributed). The 1912 U. S. Standard ends at 30 in. for the 125-lb. and 24 in. for the 250-lb., while the American Standard, barring laterals, includes brand new sizes up to 100 in. for the 125-lb. and 48 in. for the 250-lb., and the question of desirability of making changes in the 1912 U. S. Standard would have probably gone unnoticed had it not been for the great number of new sizes now included in the American Standard. There has been probably as much time, effort and work expended on devising the additional sizes mentioned as that claimed by the Master Steam and Hot Water Fitters' Association in the 1912 U. S. Standard, with the added difficulty of blending the larger sizes of the American Standard with the smaller ones of the 1912 Standard in such a way that the large sizes of the American Standard would not appear absurdly excessive in dimensions, and that the complete standard would show just as much uniformity of design in the smaller, as in the larger sizes. A careful inspection of the book of curves of bolt circles, flange diameters and thicknesses, center to face dimensions of fittings, etc., of the American Standard will show with what degree of success it compares with the curves shown for the 1912 Standard.

It has been claimed by the Master Steam and Hot Water Fitters' Association that there have been 250 changes made in the 1912 Standard. In reference to flanges and bolting, contained in the rather contracted scope of the 1912 Standard sizes, Fig. 16 of the committee's report (Fig. 1 herewith) would indicate about 18 changes. The American Standard bolt stress curves clearly show the advantage over the other curves. As a great part of the stress in a small bolt is due to making up a tight joint, it seems advisable to figure for a low stress due to live load. As the diameter of the bolt increases, the initial stress per sq. in. of bolt metal due to making up a tight joint bears a smaller proportion to the stress per sq. in. of bolt metal due to live load. This latter stress can be increased within safe limits in proportion as the diameter of the bolt increases; in fact, in the very large sizes of the American Standard, 250-lb. weight, it was found difficult to keep the bolt stresses much below 5000 lb. per sq. in. on account of not having enough room to spare between nuts for wrenches. It, therefore, appeared reasonable to start at the 10-in. size with the bolt stress of 2231 lb. and gradually increase to 4913 lb. per sq. in. on the 48-in. size. In regard to the remaining changes in lengths of fittings within the scope of the 1912 U. S. Standard sizes, with the exception of reducing fittings, most of the changes are practically invisible to the eye when plotted to scale, and where there is a visible change the American Standard evidently shows to advantage.

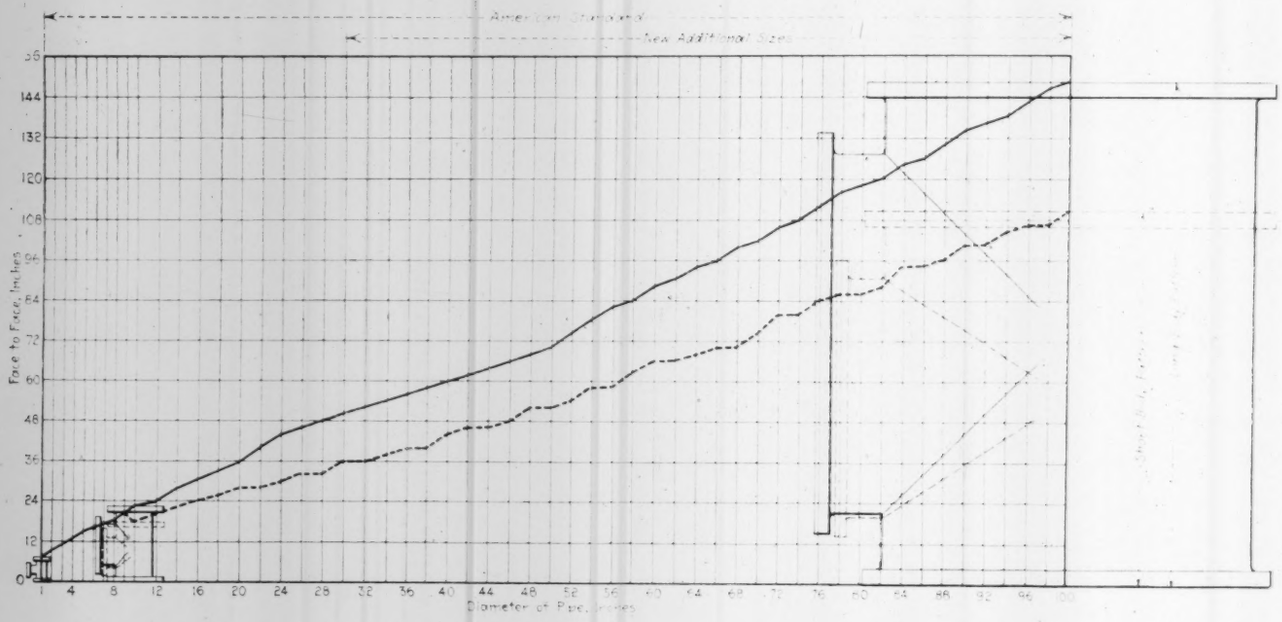


Fig. 4 Curves showing Face to Face Dimensions of Long and Short Body Tees and Crosses, 125 lb. Working Pressure

Another point in the American Standard that may be worthy of mention, is that pertaining to minimum pipe wall thicknesses. This was not considered in the 1912 U. S. Standard, although it certainly seems to be more important than a slight change in a face to face dimension of a fitting, as it involves the strength of the fitting, while the face to face dimension is simply a question of more or less length.

Interchangeability in the American Standard has not only been carried out for the sizes 1 to 10 in., but extended throughout the entire list in the long body patterns. Another class of interchangeability also exists in short body patterns. For economy's sake, the short body patterns have been standardized for sizes of outlets so small in diameter as to warrant a shorter length of body. The difference in length of run between the two patterns is shown graphically in Figs. 4 and 5.

In consideration of the fact that the cost per running foot

of cast-iron fittings is, approximately, twice that per running foot of cast-iron pipe, and four times that of pipe with cast steel as a basis, it seems advisable to include the short body patterns within reasonable limits for diameters of outlets. Take, for instance, a 125-lb., 100 in. by 100 in. by 98 in. reducing tee; this fitting has dimensions that are interchangeable with standard and reducing tees and crosses with outlets as small as 68 in. in diameter, the length face to face being 148 in., and center to face of outlet 74 in.; for all reduction of outlets below 68 in. diameter, the face to face dimension is 110 in. Would any good engineer consider it economical or advantageous to design a fitting (148 in.—110 in.), or 38 in. longer than necessary in order to make it interchangeable with all other fittings, when the difference in cost per foot is as stated above, especially when perhaps only one plant out of many may have occasion to replace a tee with a cross.

Figs. 4 and 5 of face to face dimensions are given to indicate graphically why a long and short body pattern is advisable between the limits of 10 in. to 100 in. on the 125-lb., and 10 in. to 48 in. on the 250-lb.

H. G. Stott, in closing, said that several statements had been made in the discussion which were at variance with the facts. One of these is that the U. S. Government in all its departments has continued to use the 1912 U. S. Standard.

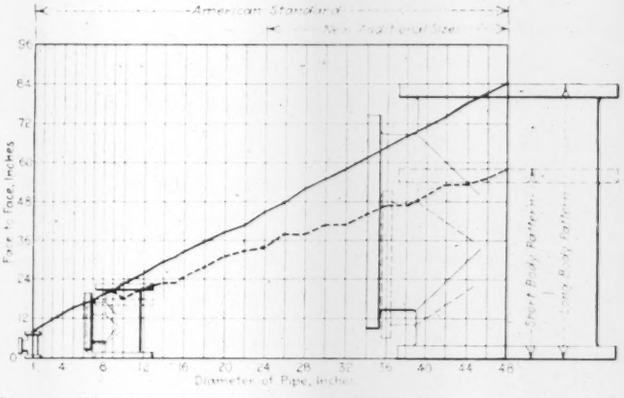


Fig. 5 Curves Showing Face to Face Dimensions of Long and Short Body Tees and Crosses, 250 lb. Working Pressure

He had a letter from Dr. Stratton, director of the Bureau of Standards, dated April 3, 1913, which expressed the desire of the Bureau to use its offices in bringing together the various interests with a view to effecting the standardization of flanges and flange fittings. This did not indicate the present acceptance of a standard by that department and the Navy Department has its own standard with bolt circles entirely different from the 1912 U. S. Standard.

Also, in the matter of changes in the present report. Referring to Figs. 2 and 3 (in this issue), there will be found a comparison of dimensions of ells, tees and crosses for the Manufacturers' Standard, the 1912 U. S. Standard and the proposed American Standard. It will be seen that the differences in dimensions are almost infinitesimal. This is only a sample and a review of the other comparative curves of the report will show that the changes proposed are slight and in the nature of compromises between the Manufacturers' Standard and the 1912 U. S. Standard.

The Committee's report is identical with that of the committee of the Manufacturers' Association which has been adopted by them and is being published in manufacturers' catalogues. The general broad principles of compromise followed in the meetings with the Manufacturers' Association were these: That they would adopt our stresses and bolt circles and diameter of bolts and we would adopt as much as possible of their fittings. In working to that it became necessary for the manufacturers to change many of their standard dimensions of fittings. He said further:

In engineering matters we are probably never able to realize the ideal. Practically all engineering is the result of compromise. We found in actual practice that we were unable to get the 1912 U. S. Standard fittings on the market from the firms with whom we were dealing without paying an additional price. In other words, these were not standard fittings. This complaint came from innumerable firms. The attitude of two of the large railroad companies was a decisive factor in the determination that we should not adopt the 1912 U. S. Standard. I appealed to the engineers of these railroads personally, and asked them why they did not adopt this standard, and they said they could do nothing with the purchasing department on this basis.

In regard to interchangeability, all tees and crosses in the American Standard are interchangeable up to and including 9 in., the same as in the 1912 U. S. Standard. Beyond that all long body tees and crosses are interchangeable among themselves and all short body tees and crosses are interchangeable among themselves. It must be remembered that in this report we have extended the dimensions of the standard weight fittings from 30 in. to 100 in., for the light, and from 24 in. to 48 in. for the heavy. The demand for these sizes has come up from time to time, not only from the waterworks people, but from others who have use for these large sizes: for example, in large turbine work exhaust pipes up to 100 in. are not unusual. These sizes have been carried up consistently. In drawing any curve it is a well known fact that the upper points of the last ends of curves are usually indefinite, because there are no further points determined, so in going up to the larger sizes some of the other points were found not to conform to that curve, and therefore they were changed.

In regard to the two waterworks associations, their statement was this: That until they settled their own differences, one of the principal being whether the dimension of the pipe should be inside or outside, there was no use in trying to do anything with them, and as our own people required these larger sizes, we went ahead and developed the standard as given here.

The attitude taken by the Master Steam and Hot Water Fitters' Association is astonishing. At the last conference with them they agreed to the new schedule as presented here, except that they demanded first that it should be called "The 1912 Standard, Revised," instead of "The American Standard of 1914," and second that all tees and crosses should be made interchangeable. This leaves only the name and the tees and crosses over 10 in. in size as debatable ground. A copy of this resolution was sent to their chairman, Mr. English, which he approved except that he said there was not sufficient emphasis on the fact that the name should be retained. There has not been a single technical question raised in this discussion; the subject is treated entirely as a question of policy. Your committee has spent an enormous amount of time on the development of the standard, and given careful